UNITED STATES

DEPARTMENT OF AGRICULTURE

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The Works of

Warner W. Stockberger (1872-1944)

with

Biographical Memoir

and

Bibliography

Volume I

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Memorial Volumes

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2. The Drug Known As Pinkroot. U. S. Dept. Agr., Bur. Plant Indus. Bul. 100, Part V, pp. 5 - 8, illus. (Reprint) 1906.

3. Pinkroot and Its Substitutions. Pharmaceutical Science Series, Monograph No. 16. Ed. by Edward Kremers. Pharmaceutical Review Publishing Co., Milwaukee. 65 pp., illus. 1907.

4. Cunila Mariana L., a Substitute for Spigelia. Journal of the American Pharmaceutical Association 3: 33 - 34. 1914.

5. Field for Drug-plant Breeding. Journal of the American Pharmaceutical Association 3: 166 - 169. 1914.

6. Medical Plant Gardens. American Journal of Pharmacy 86: 506 - 511. 1914.

7. Drug Plants under Cultivation. U. S. Dept. Agr. Farmers' Bul. 663, 37 pp., illus. 1915. (Rev. 1935)

8. Drug-plant Culture in 1916. Journal of the American Pharmaceutical Association 5: 1068 - 1075, illus. 1916.

9. How to Cultivate Botanical Drugs. Pharmaceutical Era 49: 179 - 181, illus. 1916.

10. Medicinal and Aromatic Plants. In Gardner, F. D., Successful Farming, pp. 424 - 428. Philadelphia. 1916.

11. Physiological Observations on Alkaloids, Latex and Oxidases in Papaver Somniferum. (With R. H. True) American Journal of Botany 3 (1): 11 pp. 1916.

12. Production of Drug-plant Crops in the United States. U. S. Dept. Agr. Yearbook Separate No. 734, 10 pp., illus. 1917.

13. Production of Volatile Oils in the United States. American Perfumer 3: 8 - 9, 24, illus. 1918.

14. Some Plain Facts about Drug Cultivation. Druggists Circular 62: 106 - 108, illus. 1918.

DRUG PLANTS, Cont'd

15. Commercial Drug Growing in the United States in 1918. Journal of the American Pharmaceutical Association 8: 807 - 811. 1919.

16. Ginseng Culture. U. S. Dept. Agr. Farmers' Bul. 1184, 17 pp., illus. 1921. (Rev. 1941)

17. Chemical Examination of a Venezuelan Jaborandi. (With O. F. Black and J. W. Kelly) American Journal of Pharmacy 95: 4 - 7. 1923.

18. List of Medicinal Plants Grown in School of Pharmacy Drug Gardens in the United States. U. S. Dept. Agr., Bur. Plant Indus. (Processed) 14 pp. 1923.

19. Status of Drug-plant Growing in the United States in 1921. Journal of the American Pharmaceutical Association 12: 120 - 122. 1923.

20. List of Medicinal Plants Grown in Drug Gardens of Schools of Pharmacy and Other Institutions in the United States during the Years 1927 to 1929. U. S. Dept. Agr., Bur. Plant Indus. (Processed) 15 pp. 1930.

21. Division of Drug and Related Plants. Annual Reports of Department of Agriculture, pp. 6 - 8. 1934.

II. GENETICS

1. A Literary Note on Mendel's Law. American Naturalist 46: 151 - 157. (Reprint) 1912.

2. A Literary Note on the Law of Germinal Continuity. American Naturalist 47: 123 - 128. (Reprint) 1913.

III. PLANT PHYSIOLOGY

1. The Bisexual Inflorescence of Humulus Lupulus. Science (n. s.) 27: 338 - 339. 1908.

2. Change of Sex in Humulus Lupulus not Due to Traumatism. Science (n. s.) 31: 632 - 633. 1910.

3. The Effect of Some Toxic Solutions on Mitosis. Botanical Gazette 49 (6): 401 - 429, illus. (Reprint) 1910.

IV. TANNIN

1. Dekker's Monograph of the Tannins. Journal of the American Leather Chemists Association 4: 258 - 259. 1909.

2. The Production of New Tanning Materials in the United States. Journal of the American Leather Chemists Association, pp. 35 - 46. (Reprint) January 1910.

3. Tannin Plants of Paraguay. Journal of the American Leather Chemists Association, pp. 185 - 192. (Reprint) April 1912.

4. The Geographical Distribution of Tannin Plants. Journal of the American Leather Chemists Association, pp. 33 - 40. (Reprint) January 1913.

V. HOPS

1. Growing and Curing Hops. U. S. Dept. Agr. Farmers' Bul. 304, 39 pp., illus. 1907.

2. Improvement of Hops by Selection and Breeding. Proceedings of the American Breeders' Association 4: 156 - 161. 1908.

3. Some Problems and Possibilities in Hop Culture. Science 27: 425 - 426. 1908.

4. Sources of Arsenic in Certain Samples of Dried Hops. U. S. Dept. Agr., Bur. Plant Indus., Bul. 121, Pt. IV, pp. 41 - 46. (Reprint) 1908.

5. Verbesserung der Qualität Amerikanischen Hopfens. (Translation) Allgemeine Brauer und Hopfen Zeitung 48: 403 - 406. 1908.

6. Hopfenbau und Hopfendarren in den Vereinigten Staaten. (Translation) Allgemeine Brauer und Hopfen Zeitung 48: 1343 - 1347, 1410 - 1413. 1908.

7. Die Notwendigkeit Neuer Normen für die Bewertung des Hopfens in Amerika. (Translation) Allgemeine Brauer und Hopfen Zeitung 49: 2119 - 2121. 1909.

8. Necessity for New Standards of Hop Valuation. U. S. Dept. Agr., Bur. Plant Indus., Cir. 33, 11 pp. 1909.

9. Some Conditions Influencing the Yield of Hops. (With James Thompson) U. S. Dept. Agr., Bur. Plant Indus., Cir. 56, 12 pp. 1910.

10. Progress of Hop Culture in the United States. Second International Brewers' Congress Proceedings 1: 201 - 210. (Reprint) 1912.

HOPS, Cont'd

11. Some Effects of Refrigeration on Sulphured and Unsulphured Hops. (With Frank Rabak) U. S. Dept. Agr., Bur. Plant Indus., Bul. 271, 21 pp. 1912.

12. A Study of Individual Performance in Hops. Proceedings American Breeders' Association 7: 452 - 457. (Reprint) 1912.

13. Relation of Stand to Yield in Hops. (With James Thompson) U. S. Dept. Agr., Office of Drug-plant, Poisonous Plant, and Fermentation Investigations, Cir. 112, pp. 25 - 32. (Reprint) 1913.

14. Presence of Arsenic in Hops. (With W. D. Collins) U. S. Dept. Agr., Bur. Plant Indus. and Bur. Chem., Bul. 568 (Professional paper), 7 pp. 1917.

15. Hops. Manuscript of article prepared for Young People's Encyclopedia of Agriculture. 5 pp. Chicago. 1924.

16. Improving the Quality of Domestic Hops. Transactions of American Brewing Institute 4: 21 - 32. 1908. (Reprint of address 1936)

VI. MISCELLANEOUS (Scientific)

1. General Index to the First Ten Volumes of the Bulletin of the Scientific Laboratories of Denison University. From 1885 to 1897 Inclusive. Bulletin of the Scientific Laboratories of Denison University. 39 pp. Granville, Ohio. 1904.

2. Further Notes on Anthurus Borealis. Ohio Naturalist 6: 517. 1906.

3. A Convenient Traveling Balance. Botanical Gazette 45: 269 - 270. 1908.

4. Vanilla Beans in the United States. Address made at Third Annual Meeting of the Flavoring Extract Manufacturers' Association, Baltimore, Md. 2 pp. 1912.

5. The Social Obligations of the Botanist. Science (n. s.) 39: 733 - 748. (Reprint) 1914.

6. Relative Precision of Formulae for Calculating Normal Plot Yields. Journal of the American Society of Agronomy 8: 167 - 175. (Reprint) 1916.

7. Sunflower. U. S. Dept. Agr., Bur. Plant Indus. 3 pp. (Processed) 1921.

8. Plants Poisonous to Livestock Found on Southwestern Ranges. (With W. W. Eggleston) American Hereford Journal 13: 88 - 91, 122 - 123, illus. 1922.

VII. PERSONNEL AND PUBLIC ADMINISTRATION

1. Address on Personnel Problems. U. S. Dept. Agr., Official Record 6 (No. 47): 1, 5 - 6. 1927.

2. Address on University Training for Government Service. U. S. Dept. Agr., Official Record 10: 231. 1931.

3. Report of the Director of Personnel and Business Administration. In Annual Reports of Department of Agriculture, 17 pp. 1931.

4. The Personnel Problem in the United States Department of Agriculture. In University Training for the National Service, Part II, Agriculture. Proceedings of a Conference Held at the University of Minnesota, July 14 - 17, 1931. Pp. 81 - 105. University of Minnesota Press, Minneapolis. 1932.

5. Report of the Director of Personnel and Business Administration. In Annual Reports of Department of Agriculture, 11 pp. 1932.

6. ______________ 11 pp. 1933.

7. ______________ 15 pp. 1934.

8. ______________ 6 pp. 1935.

9. ______________ 7 pp. 1936.

10. The Need for Career Administrators. The Annals of the American Academy of Political and Social Science 189: 91 - 96. 1937.

11. Report of the Director of Personnel and Business Administration. In Annual Reports of Department of Agriculture, 7 pp. 1937.

12. ______________ 10 pp. 1938.

13. Leadership. In Morstein Marx, Fritz, Ed., Public Management in the New Democracy, pp. 59 - 67. New York and London. 1940.

14. As I See It, Observations of a Civil Servant. 51 pp. Graduate School, United States Department of Agriculture, Washington, D. C. Ed. 2, revised and with additions. 1941.

WARNER W. STOCKBERGER (1872-1944)

I

Warner W. Stockberger was born on a farm in Licking County, Ohio, on July 10, 1872. A studious child, he read everything the home library afforded, although this literature was limited largely to the thrilling serials published in the New York Ledger and to the adventures of such heroes as Robinson Crusoe and Kit Carson. Never strong, young Stockberger knew himself to be physically and temperamentally unfit for farm work. He determined therefore to seek a sound education which would help him to find a place in that larger world of which he had dreamed, financing his training by teaching between periods of study. By this "hitch-hiking" method he was enabled to study at the Utica, Ohio, Normal School and Doane Academy at Granville, Ohio, and advanced from a teacher in the grade schools to a high school instructor. Finally, he received a student-instructorship at Denison University and began to work for a degree. In 1902, he took a B. S. at Denison, and for a year held an instructorship in botany there.

In 1903, Warner Stockberger gave up teaching to enter the Bureau of Plant Industry in the United States Department of Agriculture, as an expert in histology. He continued his studies, however, and in 1907 received a Ph. D. from George Washington University. For 20 years he worked chiefly in the biological sciences, to which he made outstanding contributions, especially in the fields of pharmacognosy, plant physiology, and plant breeding. His investigations always had in view the practical application of results to the problem of production and use in agriculture, industry, and materia medica.

When Dr. Stockberger came to Washington, he was particularly interested in botanical drugs, their identity, histology, and the detection of adulterants in the crude drug trade. He made a notable contribution through his study of pinkroot and its adulterants and published material both through Department channels and in professional journals which explained the decline of the therapeutic value of this plant as handled in the trade. One of these articles was a comprehensive, illustrated monograph on "Pinkroot and Its Substitutions," which appeared in the Pharmaceutical Science Series in 1907.

He was concerned also with certain phases of plant physiology and conducted investigations on the oxidases in the latex of the opium poppy in relation to the formation of morphine and related alkaloids in the plant under various conditions. An article on this subject was published in the American Journal of Botany in 1916, by Stockberger and True.

Dr. Stockberger was one of the first to advocate the maintenance of medical plant gardens in connection with the teaching of materia medica in schools of pharmacy, as a means of familiarizing students with the living plants that furnish the therapeutic agents handled in prescription work. He encouraged

the establishment of such gardens throughout the country and furnished seed and other propagating materials of species not readily available from other sources. In 1923 and again in 1930 he prepared inventories of all such species under cultivation in these various gardens and thus facilitated the exchange of materials and planting stock between the colleges.

The commercial growing of drugs received much of his attention and he recognized the limitations and the economic problems involved. Thus the division under his administration was the principal source of reliable information for those who might otherwise have been deceived by popular articles into thinking that the growing of drug plants was an easy way to wealth. He wrote Farmers' Bulletin 663, "Drug Plants under Cultivation," which appeared in 1915, was revised in 1935, and is still distributed. Another Farmers' Bulletin on "Ginseng Culture," which first appeared in 1921, was revised in 1941. The United States Department of Agriculture Yearbook of 1917 contained an article by Dr. Stockberger on "The Production of Drug-plant Crops in the United States." In addition, many of his articles on the subject appeared in such periodicals as the Journal of the American Pharmaceutical Association, the Druggists' Circular, the Pharmaceutical Era, and the American Journal of Pharmacy.

The American hop grower owes much to Dr. Stockberger for his extensive study of the factors that affect the yield of hops in commercial hop fields. He recognized that hop growers were in severe competition with European producers and spent the summer of 1911 in the principal hop-growing regions in England and on the Continent studying the types that were being exported to the United States. Upon his return, he proposed a research project on hop varieties involving the introduction of the superior types from Europe and their critical study when grown in the hop-producing regions here. This early recognition of the problems of the hop grower became the basis for a research program in hop improvement by the Department of Agriculture in cooperation with the experiment stations in the hop-growing States. A number of official publications were written by Dr. Stockberger or by Stockberger and others between 1907 and 1917. Besides these, many of his articles dealing with the various phases of the breeding and improvement of hops appeared in scientific and professional journals. Three of these were translated and appeared in a German periodical.

Another field of study embraced by Dr. Stockberger was the world's resources of tanning materials, with particular reference to domestic sources and the desirability of reducing the dependence of the tanning industry on imported materials. Among his publications on the subject was a paper printed in 1910 pointing out the possibilities of developing a domestic supply by placing under cultivation certain wild plants.

During his years as a research scientist, Dr. Stockberger published many other articles in professional and scientific journals on genetics, plant physiology, and miscellaneous scientific subjects. He also spoke before many professional, scientific, and trade societies on the subjects of his investigations.

In 1913, Dr. Stockberger assumed charge of the Office of Drug Plant and Poisonous Plant Investigations (eventually called the Division of Drug and Related Plants), and continued in this capacity until he took up personnel work in the Department of Agriculture in 1923. He remained nominal head of the division, a sort of chief emeritus, until July 1, 1940.

II

During his scientific career, Dr. Stockberger had been interested in problems of management and particularly of human relations. He had served on bureau committees dealing with efficiency ratings and promotions and for some time carried the general administrative responsibility of the Office of Physiological Investigations. In 1919 and 1920 he was detailed to a Congressional Joint Committee on Reclassification of Salaries as one of the representatives of the Department. As early as 1914, he had spoken on "The Social Obligations of the Botanist" before the Washington Botanical Society, urging a conception of botany which would take into account economic and social factors. In fact, his natural inclinations, training, and experience fitted him well for the job which Secretary Henry C. Wallace gave him in 1923 of carrying out the provisions of the Classification Act, and the change from scientific pursuits to personnel administrator was not as radical as it seems.

In 1925, various personnel and administrative officers were consolidated in the Office of Personnel and Business Administration with Dr. Stockberger as director. The Director of Personnel was made a staff aide of the Secretary with rank equal to that of a bureau chief and thus helped to put the personnel administration of the Department of Agriculture on a firm basis many years before the work in other Federal agencies was so well established. Since 1934 the Office of Personnel has been a separate unit. Dr. Stockberger organized and was elected the first president of the Society of Personnel Administration in 1937. He was President Emeritus of that Society at the time of his death.

The man who told his fellow botanists that science is of no value as an end in itself believed that personnel administration was only a tool for getting things done well. He believed in two-way communication between those who issue orders and those who receive them. His brochure of 36 short essays, entitled "As I See It," sets forth much of the author's philosophy of life and his policy of administration. He recognized the great responsibility of the central personnel office and the Director of Personnel, and was interested in many activities which contributed to the general welfare of employees. To use his own words: "administration becomes democratic when it is motivated by supreme respect for human personalities." In his dealings with other agencies he was often the scientist who believed in letting the facts speak for themselves. Speaking of the change from scientific work to personnel administration, one of his old associates remarked that Dr. Stockberger had been "a humanitarian all his life." And it is true that his efforts both in scientific research and in personnel administration were directed solely toward the betterment of human welfare.

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The man who told his fellow botanists that science is of no value in and in itself believed that personnel administration was only a tool for getting things done well. He believed in two-way channels of relations between management officers and those who actually produce. His statement of 30 short sentences entitled "As I See It," sets forth much of the author's philosophy of life and his policy of administration. He recognized the great responsibilities of the central personnel office and the Director of Personnel, and was interested in many activities which contributed to the general welfare of employees. In his own words: "Good administration respects human dignity when it is motivated by genuine respect for human personalities." In his dealings with other agencies he was often the scientist who believed in letting the facts speak for themselves. Speaking of the change from scientific work to personnel administration, one of his old associates remarked that Dr. Stockberger had been a humanitarian all his life." And it is seen that his efforts both in scientific research and in personnel administration were directed solely toward the betterment of human welfare.

For almost 20 years Dr. Stockberger guided the development of personnel in the Department of Agriculture and extended his influence in the field of personnel generally. When because of poor health, it seemed advisable to lay down the heavy administrative burden, he was made Special Adviser to the Secretary of Agriculture on the problems of departmental administration. At this time, Secretary Henry A. Wallace wrote to him: "The development of work in the field of administrative management in this Department under your leadership has been outstanding," at the same time expressing appreciation of Dr. Stockberger's "long, loyal, and efficient service."

In July 1942, Dr. Stockberger reached retirement age, but stayed on for a year and a half at the request of Secretary Wickard, retiring on January 1, 1944. He continued as collaborator with the Department until his death on May 27, 1944. Summing up his life and work, we might say that he was that comparatively rare being who possessed a sympathetic appreciation and broad understanding of human nature, and who at the same time was capable of translating that appreciation and understanding into sound personnel administration in government.

for it has borne our burden and assumed our responsibilities and thus deprived us of the right to be over-critical.

C. H. L.

ORIGINAL ARTICLES

A CHEMICAL EXAMINATION OF A VENEZUELAN JABORANDI.[1]

By O. F. Black, J. W. Kelly and W. W. Stockberger.

A species of *Pilocarpus* occurs in northwestern Venezuela which is locally known as "borrachera" on account of its intoxicating effect upon animals which have eaten the leaves of this plant. Ernst,[2] who published a brief note on this species in 1883, gave Dr. J. Freites of Barquisimeto as his authority for the following statement regarding the plant and its effect upon animals: "This shrub grows in dry and hot localities in the vicinity of Barquisimeto; it sends up from the ground several shoots which grow to a height of one and one-

[1] Contribution from the office of Drug, Poisonous, and Oil Plant Investigations, Bureau of Plant Industry, U. S. Department of Agriculture.

[2] Ernst, A. Un Jaborandi Venezulano. *El Ensayo Medico*, Vol. 1, No. 8 pp. 61-62. Caracas, 1883.

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half to two meters. It causes in animals which eat it, a sort of intoxication or drunkenness from which the plant derives its name; also it induces profuse perspiration and salivation."

Specimens of the plant received by Ernst from Barquisimeto were provisionally determined by him as *Pilocarpus heterophyllus* A. Gray, a species which was discovered about 1857 by Wright [3] in Cuba. Early in 1922 the writers received from Dr. H. Pittier, Director of the Commercial Museum at Caracas, a quantity of leaves of the borrachera with the comment that a careful study of the plant had led him to consider it a new species of *Pilocarpus*, the name for which unfortunately he has not yet published. The relationship of this Venezuelan Jaborandi to the official species of *Pilocarpus* at once suggested that it might contain pilocarpine or some of the other alkaloids which occur in this group of plants. A study of the material received from Dr. Pittier, which consisted of about five pounds of well preserved leaves, was therefore undertaken to determine what active principles were present.

A preliminary test of a small quantity of leaves macerated in Prolius' solution gave a positive reaction for alkaloids. Next, 60 grams of leaves were coarsely ground, placed in a Soxhlet apparatus and exhausted successively with ether, chloroform, acetic ether, ethyl alcohol, and finally acidulated water. The chloroform, acetic ether, and alcohol fractions each gave a positive reaction for alkaloids, that of the alcohol fraction being the strongest. The acidulated water fraction gave no reaction, thus showing that the extraction of the alkaloid was complete before that solvent was applied.

Later 600 grams of finely powdered material was moistened with 95 per cent. alcohol containing 1 per cent. HCl, and percolated with 1 liter of acid alcohol, followed by 4 to 5 liters of neutral alcohol. The combined extract was neutralized with ammonia, concentrated to a small volume by distillation under reduced pressure, and the residue freed from the large amount of chlorophyl and other extractive matter present by treatment with successive portions of 1 per cent. HCl. About 1 liter of acid solution was thus obtained, which

[3] Grisebach, A. Plantae Wrightianae. *Memoirs Amer. Acad. Arts and Sciences*, n. s., Vol. 8, p. 170. 1861.

was neutralized with ammonia, concentrated in vacuuo to about 150 c. c., then made strongly alkaline with ammonia and shaken out with chloroform, eight portions being used, or about 250 c. c. in all. After this procedure the solution still gave an alkaloidal reaction. The chloroform was then distilled off, and the residue, dried in a desiccator, consisted of 1.49 grams of a brown amorphous mass, equivalent to 0.25 per cent. of the weight of the leaves extracted.

The crude alkaloid was treated with dilute HCl, which dissolved all but a slight quantity of the brown gum. The filtered solution was made strongly alkaline with ammonia and shaken out with $CHCl_3$, three extractions being sufficient to completely remove the alkaloid. The partly purified alkaloid was dissolved in a few c. c. of absolute alcohol made faintly acid by the addition of an alcoholic solution of nitric acid. After standing a short time crystals began to separate from the solution. These were allowed to grow for several hours and were then removed by filtration with suction and washed with alcohol and ether. The crystals, which were small, colorless prisms, weighed 0.22 grams, which is equivalent to about 0.04 per cent. of the weight of the leaves.

That this product is pilocarpine nitrate is proved by its crystalline form, the solubility of the free base in alkalies, its response to the ordinary tests for alkaloids, and its melting point, which was found to be 170° after one crystallization and 173° after a further recrystallization. Jowett [4] gives 176°-178° as the true melting point of the pure salt. It is quite probable that the product obtained in the laboratory contained some slight impurity which a further recrystallization would have removed.

Whether the leaves of the Venezuelan *Pilocarpus* can be used as a source of pilocarpine is doubtful since they do not compare favorably with either *Pilocarpus jaborandi* or *P. microphyllus* in alkaloidal content. The following table, adapted from Henry,[5] gives the principal facts known about a number of species of *Pilocarpus*, to which have been added the facts just recorded about the Venezuelan species.

[4] Jowett, H. A. D. The assay of preparations containing Pilocarpine and the characters of Pilocarpin nitrate and Hydrochloride. *Pharm. Journ.*, Vol. 63, pp. 91-93. 1899.

[5] Henry, T. A. The Plant Alkaloids, p. 302. 1913.

Table I. Alkaloids in Different Species of Pilocarpus.

Name.	*Constituents.*	*Total Alkaloids*	*Crystalline Pilocarpine Nitrate*
		Per cent.	*Per cent.*
Pernamubuco Jaborandi (*Pilocarpus jaborandi*)	Pilocarpine iso-pilocarpine Pilocarpidine	0.72	0.67
Paraguay Jaborandi (*Pilocarpus pennatifolius*)	Pilocarpine iso-pilocarpine	0.2 to 0.3	——
Marahan Jaborandi (*Pilocarpus microphyllus*)	Pilocarpine iso-pilocarpine	0.765 to 0.783	——
Guadeloupe Jaborandi (*Pilocarpus racemosa*)	Pilocarpine iso-pilocarpine	——	0.45 0.12
Ceara Jaborandi (*Pilocarpus trachylopus*)	Not known	0.4	
Aracati Jaborandi (*Pilocarpus spicatus*)	Ψ-Pilocarpine Ψ-Jaborine	0.16	
Venezuelan Jaborandi (*Pilocarpus* n. sp.=P. *heterophyllus*)	Pilocarpine	0.25	0.04

As shown by Jowett, the value of *Pilocarpus* as a drug depends chiefly upon its pilocarpine content, since the iso-pilocarpine and other alkaloids which have been identified are less powerful in their action. An examination of the table shows that the Venezuelan species has not only a much smaller percentage of total alkaloids than *Pilocarpus jaborandi,* but the percentage of pilocarpine is also very much less. However, it compares favorably with several of the other species in the series.

There is little reason to doubt that the poisonous effect of Venezuelan Jaborandi on livestock is due to the alkaloids present in this species since the symptoms recorded by Ernst are among those recognized as evidence of pilocarpine poisoning.

TABLE 2.

Experiment No.	Strychnine in 50 mils.	Strychnine found.	%.	No. shakings.
1	0.0376 Gm.	0.0360 Gm.	95—	5[5]
2	0.0376 Gm.	0.0375 Gm.	99.9	7
3	0.0182 Gm.	0.0182 Gm.	100	7
4	0.0182 Gm.	0.0176 Gm.	97	5[5]

CONCLUSIONS.

The method, as shown by the results of the experiments tabulated above, is certainly reasonably accurate, in the hands of the writer at any rate. A comparison of this method with the other three methods is now being carried out by the writer, who hopes to present the results of his comparative study in the form of a paper at an early date.

LABORATORIES OF PHARMACOLOGY,
SCHOOL OF MEDICINE,
EMORY UNIVERSITY,
ATLANTA, GA.

COMMERCIAL DRUG GROWING IN THE UNITED STATES IN 1918.*

BY W. W. STOCKBERGER.[1]

When some historian of the future writes the history of drug plant growing in the United States, the eventful year 1918 will stand out in sharp relief as a period of readjustment of popular opinion with regard to this important subject. The cumulative effect of the unusual conditions occasioned by the great war cannot yet be fully determined, nevertheless there is much positive evidence that certain important changes have occurred in the drug growing industry. By no means the least of these is the partial emergence of drug growing from the romantic phase which has been so pronounced during recent years into one which is more prosaic but certainly far more sensible and businesslike. Another change, brought about for the most part by bitter experience, is the growing realization that drug growing as a business proposition does not differ essentially from other types of agricultural enterprises, particularly in respect to crop risks and marketing problems, or if any appreciable difference is to be noted it is in the direction of greater uncertainty as to the successful outcome.

Stimulated by the high price levels reached by many important crude drugs during the early period of the war, or hoping thereby to render a patriotic service to our nation in a time of need, the commercial production of crude drugs was undertaken by numerous individuals who had little or no experience in this particular enterprise. In a regrettably large number of cases the outcome was very disappointing although this contingency had been foreseen and publicly predicted in advance by those whose previous experience placed them in a position to judge the situation fairly.

The situation with respect to some of the most important drug crops grown in 1918 fully demonstrates the danger of overproduction regarding which much

[5] After last shake-out still gave a decided precipitation with Mayer's reagent.

* Read before Scientific Section, A. Ph. A., New York meeting, 1919.

[1] Physiologist in Charge, Office of Drug, Poisonous and Oil Plant Investigations, Bureau of Plant Industry.

has been said in recent years. The growers of belladonna for example although not very numerous found that the product from the relatively small acreage planted was more than the market would readily absorb, and it was soon currently reported in the trade that there was a heavy overproduction of the drug with the natural result that the price rapidly declined to a figure that was discouragingly low to the grower. Producers of cannabis and digitalis also experienced some difficulty in finding a satisfactory market although price fluctuation in the case of these two drugs was not very great.

From such information as it has been possible to secure, it appears that marketable quantities of the following annual drug crops were produced under cultivation in this country last year: Belladonna, henbane, digitalis, cannabis, calendula and sage. Senega, mandrake, pink root, valerian, cypripedium and blood root were also grown but in negligible quantity. As in former years the following oils were produced from cultivated plants: Peppermint, spearmint, wormwood, chenopodium and tansy. To obtain accurate data on all these crops was practically out of the question for a number of reasons. The individual growers are widely scattered over the country, thus making a personal canvass impossible. The only recourse was to send out written requests for the desired information but as complete lists of the growers of various drug plants are not available it is practically certain that many growers were not called on for a report. Moreover, another element of uncertainty was introduced by the fact that no reply was made to many of the requests sent out. It must therefore be distinctly understood that the figures given later in this report are to be taken with certain reservations and that with two or three exceptions, they merely represent the reported production which may be far from the actual production.

BELLADONNA.

The war-time interest in drug growing was chiefly centered on belladonna, and the success attained by some growers in 1917 was reflected in the increased acreage planted in the year following. The general distribution of the acreage and the production are shown in the accompanying tabulation:

State.	No. of growers.	Average.	Production in pounds. Herb.	Leaves.	Stems.	Root.
Michigan	13	45.5	20950	10075	2550	9825
Indiana	7	32.73	2944	11114	3680	2445
New Jersey	4	34.75	26725	340	25	5050
Pennsylvania	6	41.75	1500	11258	1585	3017
California	24	95.63	37675	20984	5500	1430
Maryland, Virginia, West Virginia, Illinois, Wisconsin, Oregon, Iowa	6	23.35	1256	5540	2373	510
Total	60	273.71	91050	59311	15713	22277

This tabulation which represents reports from 60 growers and an area of 273 acres, or an average of 4.5 acres for each grower, shows an average yield of approximately 600 pounds of belladonna herb (including leaves and stems), per acre.

From 136 acres twenty-four growers harvested 11.13 tons of root, an average production of 164 pounds of root per acre. Summarized, the total production for the year was approximately 83 tons of herb (including leaves and stems), and 11 tons of root.

The average yield by states expressed in pounds per acre was as follows: New Jersey 780, Michigan 703, California 671, Indiana 542, Pennsylvania 343. These data are insufficient to form a basis for any sound conclusions as to the section of this country most favorable for the cultivation of belladonna. It can be stated, however, that so far the results in California have been less favorable than were expected Mr. N. R. Mueller of the Office of Drug, Poisonous and Oil Plant Investigations, visited practically all of the plantings of belladonna in California during the summer and fall of 1918 and found that in addition to the acreage reported above, about 35 acres planted to belladonna had not been harvested on account of failure of the crop. He also found that the potato stalk borer, *Trichobares trinotata*, had become a serious pest of belladonna, especially on plantings of second year growth, and that the ravages of this insect had introduced a large element of uncertainty with respect to this crop. Indeed the opinion has gained ground among growers that the cultivation of belladonna in southern California will be greatly reduced if not abandoned in the near future unless some effective means can be found to prevent the destructive action of the potato stem borer on this crop.

CANNABIS.

During the year under consideration, the quantity of cannabis produced was sufficient to meet market demands for the American grown drug. The reported acreage and production were as follows:

State.	No. of growers.	No. of acres.	Production in pounds.
Illinois	1	20	30,000
New Jersey	2	9	5,350
Pennsylvania	1	3.75	4,300
South Carolina	13	29.50	10,000
Virginia	1	20	10,000
Total	18	82.25	59,650

Owing to the different methods employed in harvesting and preparing cannabis for market, no just comparison can be made of acre yields in the different geographical locations. The South Carolina cannabis is produced under the general supervision of a representative of the Bureau of Plant Industry, and every precaution is taken to keep all of the drug marketed from that state up to the pharmacopoeial standard. After the flowering tops are harvested they are thoroughly cured under cover, then worked over by hand and all the stems and large foliage leaves removed. This process gives a drug of high quality, but greatly reduces the net or marketable yield per acre, since the portion rejected often equals or exceeds in weight the part which is regarded as suitable to offer to the drug trade.

DIGITALIS.

Judging from the reports received the cultivation of digitalis does not as yet appear to be established on a commercial basis. Small areas of cultivated digitalis,

usually from one-half to one acre in extent, were harvested in Pennsylvania, South Carolina, Washington, California and some other states. The figures which are available do not warrant even an approximate statement of the probable production but there is little doubt that with proper encouragement the quantity necessary to satisfy domestic needs would be readily available. In some sections the yield of the cultivated drug appears to be quite satisfactory, and unless the cost of production is excessive the crop should show a profit to the grower.

In addition to the strictly commercial plantings, digitalis was grown on a relatively large scale at several of the more important drug gardens which are maintained in connection with a number of Schools of Pharmacy. Several tons of digitalis leaves and a quantity of seed was also collected from plants of wild growth in the general region of the Coast Range of mountains on the Pacific Coast. The possible competition of this wild material is a factor that must be taken into account in the future development of the production of digitalis under cultivation.

CALENDULA.

Calendula continued to receive the attention of a few growers in 1918, notwithstanding the failure of the market to recover from the decline in prices that was precipitated in 1916 by the importation of this product from Japan. The reports at hand show that in 1918 two acres of calendula were grown in New York, six acres in Massachusetts, and a number of small plots in Los Angeles County, California. Some growers marketed the florets only, while others were able to sell the whole flowers in both the fresh and the dried state. Since these were not distinguished in the reports, no figure can be given for the total production.

SAGE.

Although sage is widely grown as a home and market garden crop, a comparatively small number of growers have attempted quantity production for the spice trade. Efforts in this direction have met with moderate success in Wisconsin, Missouri, Ohio, Massachusetts and South Carolina. A total of 12 growers from these states report the harvesting of from 8 to 10 acres of sage with a production of from 9,000 to 10,000 pounds. The yield per acre ranged from 300 to 1,250 pounds, the lower figure being largely due to unfavorable weather conditions which prevailed in some sections during the early part of the year.

HENBANE.

The cultivation of henbane has continued to be a very difficult problem for most growers. In the year under consideration attempts were made to grow henbane in a number of states but with little success except in Michigan, where one grower at least has been able to produce a good crop. The great decline in price from former high levels and the difficulties encountered in the production of henbane seem likely to retard progress in the cultivation of this crop at least for the immediate future.

This brief, although incomplete résumé of the situation, may serve to show something of the extent of the present development of the commerical cultivation of medicinal plants. It is evident that all of these enterprises are small and that in many cases they can hardly be regarded as having passed the experimental

stage. The experience of the past few years seems more than ever to point out the futility of depending upon a large number of amateur drug raisers to supply market demands. From the standpoint of the drug manufacturer, a constant and reliable source of supply is of primary importance, and it is believed that the interests of both producers and manufacturers will be best conserved by restricting drug growing so far as possible to those individuals who are in a position to undertake the work on a permanent business basis.

FERRUM REDUCTUM.*

BY CHARLES H. LAWALL AND J. W. E. HARRISSON.

The standards for Ferrum Reductum were changed in the U. S. P. IX to provide for greater definiteness and accuracy, but were not made any more rigid than were the requirements of the U. S. P. VIII as regards the more important tests.

The test of greatest importance from the standpoint of the prescriber is the test for limit of sulphide.

Sulphide in reduced iron originates in the process of manufacture through the fact that the ferric oxide has not been entirely freed from soluble sulphates. These sulphates in the process of reduction are changed to sulphides and enter into combination with the iron to produce ferrous sulphide. The objectionable character of this impurity will be appreciated when it is realized that Ferrum Reductum containing larger amounts of sulphide than permitted by the U. S. P. test, will give evidence of the fact by unpleasant eructations of hydrogen sulphide when the reduced iron comes into contact with the hydrochloric acid of the gastric juices.

When the present standards were framed prior to 1914, there was no difficulty in obtaining supplies of proposed U. S. P. quality nor was there any protest on the part of any manufacturers of inorganic chemicals, who were consulted in framing these standards, that the requirements could not be met. Shortly after the U. S. P. IX became official in 1916, it became apparent that Ferrum Reductum of official quality was not being supplied by the manufacturers and wholesalers. Instead, an article was furnished which either bore the anomalous or misleading subterfuge "technical" so often resorted to by chemical manufacturers or it was stated on the label that "it contains sulphides in slight excess of the U. S. P. limit."

While the responsibility lies primarily with the wholesalers and manufacturers for furnishing a substandard article which is used for no other purpose than in medicine, there is also a lack of watchfulness evident on the part of the retail pharmacist who accepts and uses such an inferior article in filling prescriptions.

If every pharmacist would have returned to the manufacturer each package so labeled and would have followed this action with a vigorous protest, it would not have taken long for American chemical manufacturers to have realized their

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* Read before Section on Practical Pharmacy and Dispensing, A. Ph. A., New York Meeting, 1919.

v 3, 1914

lot of elixir gets divided into the required number of doses by the many consumers, the slight variation in the yield of the tablets is entirely lost sight of.

Now let us consider the variation in the weight of the individual tablets themselves. It would be an endless and entirely impracticable task to attempt to weigh individually all of any large lot of tablets. Ten tabets were taken at random from each of ten different lots that had been made by different machines and the tablets were weighed separately. The maximum variation was found to be nine percent. from the average, and only seven tablets in the hundred to vary more than five percent. from the average. This variation is certainly very much less than with any of the other methods of dispensing medicines. Does it not seem, therefore, that an occasional variation of 10 percent. or even 15 percent. in the weight of one tablet from the average weight of 100 tablets should be legally allowable? Such a variation would be considered small by the other methods of administering medicines.

In conclusion the writer wishes to emphasize the following:

1st. That the methods of dispensing powders, liquids, and capsules present wide variations in the individual doses.

2nd. That tablets are by far the most accurate means of dispensing medicine.

3rd. That the average weight of a large number of tablets should contain the exact amount of the ingredients claimed by the label.

4th. That a permitted variation of 10 percent. or 15 percent. in the weight of individual tablets would not be excessive as a legal standard.

FROM THE LABORATORIES OF PARKE, DAVIS & CO., DETROIT, MICH., JULY 12, 1913.

CUNILA MARIANA L., A SUBSTITUTE FOR SPIGELIA.

W. W. STOCKBERGER, WASHINGTON, D. C.

During the last few months several crude drug dealers have submitted to the writer for verification commercial samples representing recent shipments of what was supposed to be pinkroot. Upon examination the larger number of these samples proved to be spurious. The sophistication, however, was not Ruellia, the usual adulterant, but a new one which was identified as *Cunila Mariana* L.

Virginia is given as the type locality of this plant, known locally as American, mountain, or Maryland dittany, but it is found also in the Ohio valley and the States bordering on the Southern Appalachians. It is of interest to note that within its range of distribution are included those areas in which both *Spigelia marilandica* and *Ruellia ciliosa* are most abundant.

By the gross characters of its roots Cunila may be readily distinguished from Spigelia. The dry roots of the latter are very friable and break readily with a fairly smooth and usually whitish fracture, while roots of Cunila do not break readily but when sharply bent the cortex splits off from the tough woody part in a manner strongly suggestive of Ruellia. The microscopical characters of the root as seen in cross section readily differentiate Cunila from both Spigelia and

Ruellia, but further mention of them is unnecessary since good descriptions of the anatomy of all three plants are readily available in the literature.[1]

An effort was made to trace the source which supplied this new substitute, but aside from the mere statement that a large shipment from Kentucky had reached the crude drug markets of the East, nothing was learned. It is probable, however, that more of this root will be collected and marketed and it may be possible eventually to determine the exact locality in which it is being collected.

It is an open question whether the wholesale adulteration of pinkroot which has been so much in evidence during recent years is due to carelessness, ignorance or cupidity on the part of the collectors. Manufacturers using this drug certainly can not afford to jeopardize the purity of their preparations by using the false or adulterated pinkroot, and a concerted effort to drive the spurious drug out of the markets is highly desirable.

Some definite results might follow if the large dealers in pinkroot were to furnish to local buyers for distribution among collectors, a leaflet containing a good picture of the spigelia plant and a warning against the unsatsifactory methods of collection so frequently pursued.

THE COMMERCIAL POSSIBILITIES IN GROWING MEDICINAL PLANTS.

F. A. MILLER, M. S., INDIANAPOLIS.

The commercial possibilities in growing medicinal plants are now recognized by the governments of England, Austria and the United States. The International Congress of Applied Chemistry, a society whose able efforts toward industrial development are now universally recognized, is taking active steps in the investigation of drug plant cultivation through an international committee. Universities, private institutions, and individuals have been induced to broaden their field of investigations to include medicinal plants.

From scattered, disconnected and poorly planned investigations of a minor character this work is gradually being organized with a determination that insures success. The dignity with which this movement is now being advanced removes all chances for doubt as to the practical value of drug growing. The success of such an undertaking will of necessity depend upon the commercial possibilities presented. The work in the United States has now reached a stage where these possibilities must be carefully considered.

The early history and evolution of the cultivation of medicinal plants within the U. S. and other countries has been treated elsewhere in an able manner by several authorities and need not be repeated here. It might be well to add, however, that most of the early work on drug growing was not exhaustive. It gave

[1]Holm, Th., Medicinal Plants of North America, No. 5. *Cunila Mariana* L. Merck's Report, vol. 16, pp. 188-189, 1907.

Stockberger, W. W., Pinkroot and Its Substitutes, Pharmaceutical Review, vol. 25, pp. 2-21, 33-47, 66-84, 97-107, 1907.

Mansfield, W. M. Ruellia as a Spigelia Substitute. Druggists Circular, vol. 53, pp. 110-114. 1909.

The Curing of Leaf Drugs with Special Reference to their Appearance.*

By *R. H. True* and *W. W. Stockberger.*

At the present time it is certain that many more crude drugs are bought and sold on their appearance than on their tested physiological properties. It is, therefore important for any grower or collector of crude drugs that he should strive to obtain sightly articles. In this discussion especial attention is given to leaf drugs since it is more difficult to obtain the desired appearance in leaves than in other types of crude drugs of vegetable origin.

The appearance of a crude leaf drug is dependant on (1) the wholeness of the leaf and (2) on the color. The degree to which the leaf may be broken is largely dependant on the amount of moisture present. Stramonium leaf, and many other kinds, when containing less than 5% of water are apt to be brittle. If too dry care in handling will do but little to preserve the leaf in an unbroken condition.

The color of the leaf is in general dependant on the green coloring matter known as chlorophyll. Chlorophyll is found in the superficial parts of plants impregnating minute colorless granules. Experiments have shown that light, while necessary in general for the formation of this green pigment, when present in too great intensity breaks it down, the result being a substance having a yellowish-green color. Chlorophyll is also decomposed by the action of acids even in considerable dilution with the result that a somewhat similar yellowish-green color is developed.

In addition to the chlorophyll bodies the cells of fresh leaves contain a large number of chemical compounds of whose nature very little is known. Many of them are in all probability extremely unstable and out of reach of the present methods of chemistry. Since the juice of fresh crushed leaves is markedly acid, we know that a considerable amount of one or more acids is present. In all probability many active principles exist in these cells in a dissolved state. From the evidence now at hand, it appears likely that many substances capable of reacting when brought together under proper

* Read at Kansas City meeting, A. Ph. A., 1904.

conditions exist in a dissolved state in the cell at the same time without any such reactions taking place. Indeed, some investigators have asserted that a single living cell may contain at one time both an acid and an alkali so isolated as to prevent their coming into contact with each other. This isolation is brought about by the enclosing of the dissolved substances in separate vacuoles surrounded by their membranes of protoplasm. According to this explanation, the substances are kept apart by special membranes of living material. It has been shown for tannins and several other principles that such a method of isolation is maintained.

It is also probable that enzymes of different kinds, located at such points as the activities of the plant may determine, are found in the cells of fresh leaves. Among these enzymes those carrying out oxidizing processes are of significance in connection with the preservation of the bright color of leaf drugs. Those enzymes known as oxidases are able to use the oxygen of the air in bringing about the oxidation of tannins and other compounds with the development of brown products.

It is clear from these considerations that there are stored in the living cell various substances capable when mingled of producing bodies which have an unfavorable effect upon the green color of the leaf drug. The presence of moisture in quantities sufficient to readily support chemical reactions is necessary to all of these changes.

The most conspicuous modification that marks the drying out of a leaf is the loss of water and the consequent shrinkage in bulk. A leaf may lose water up to a certain point and yet the cells constituting it may not be killed. When, however, the water loss goes beyond this point the structure of the most unstable substance, the living protoplasm, seems in some way to be injured and the protoplasm, like the copper sulfate crystal from which the water of crystallization has been removed, falls to pieces. This means the destruction of the protoplasmic layers surrounding the vacuoles in which the various isolated compounds are held, and the consequent permeability of these retaining membranes. Should the enclosed substances now diffuse together they will react according to the degree of mixture. The only practicable way to check these reactions is to continue the drying process until there is not enough moisture left to support them. Thus, further drying would tend to limit the undesirable changes initiated by the previous stage of desiccation.

Two classes of reactions are likely to result in detriment to the appearance of the drug: (1) the acid solutions of the cell by acting on the chlorophyll tend to give the product a yellowish color; (2) the oxidizing enzymes acting on the tannins and other oxidizable compounds present give the product a brownish color. When, in curing a leaf drug, it fails to lose water steadily, especially during the earlier stages, enough moisture is retained to support not only the action of the acids on the chlorophyll, but, more important still, the action of the oxidases on the oxidizable substances present, the development of a more or less marked brown color ensuing. Hence, the necessity of maintaining a steady loss of water from the leaf, especially in the earlier stages of curing.

In curing drugs by artificial heat, if the temperature to which the fresh leaf is exposed exceeds about 50° C., a cooked appearance results, accompanied by a darkening of the leaf. This may be explained, at least in part, by what has already been indicated. The protoplasm is kiled by the action of the heat and reacting compounds are freed from their isolating vacuoles in the presence of an abundance of moisture. Consequently, chemical reactions take place with great freedom, resulting in the relatively complete action of the acids with the chlorophyll and in the more prolonged action of the oxidases on the contents of the cells, both of which processes injure the color of the drug.

The following practical rules for the curing of leaf drugs may here follow by way of summary. Cure leaf drugs in such a way that the water loss is steadily maintained during the process. Dry until a degree of desiccation is reached which shall inhibit chemical reactions.

If artificial heat is used, be careful not to heat the fresh leaf to such a degree as to thereby injure the protoplasm since the death of the cells should be brought about only through water loss.

After the protoplasm has been killed carry on desiccation more rapidly until chemical reactions are inhibited. Should the leaf be collected for its volatile oils, keep the temperature low but do not fail to secure a steady water loss.

Since strong sunlight changes chlorophyll to a greenish-yellow substance, avoid too long exposure to sunlight.

Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

regular supplies of quality fiber can be assured, is now recognized [illegible] and practical way to accomplish this end. With the experience [illegible] the irrigated districts of the Southwestern States, about 100 communities [illegible] been organized during the last 3 years in the main Cotton Belt States [illegible] the cooperative guidance of Federal and State institutions and local [illegible] tural leaders. In 1933 a total of approximately 300,000 acres of [illegible] cotton was grown in the main Cotton Belt in addition to about [illegible] in the irrigated valleys. The work with one-variety communities [illegible] extended to include investigations of the quality of the fiber of the [illegible] grown, in order to obtain fuller information on the spinning quality [illegible] varieties chosen for community planting and also as a basis for the [illegible] tion of varieties showing definitely inferior fiber.

Diseases and disorders.—Special attention has been given to cotton root rot, [illegible] the most destructive of the cotton diseases. The studies have included [illegible] laboratory and field experiments, and though no effective remedy has yet been found, new information is being obtained on various aspects of the problem which gives promise that control measures may eventually be developed.

A practical method for preventing the occurrence of crazy top, a disorder responsible for heavy losses in cotton production in Arizona, was demonstrated in 1933. On calcareous soils it was found that irrigations applied with sufficient frequency to prevent checking of growth prevented the trouble.

A study of cotton fiber quality, especially the effects of so-called "stress" conditions resulting from high temperatures and uneven distribution of irrigation water in impervious soil, was made in Arizona, and the results were reported in Technical Bulletin 392.

FIBER FLAX

Breeding and agronomic work with fiber flax was continued at the field station at Corvallis, Oreg., where more than 300 different selections, strains, or varieties were grown for comparison. In a test in a farmer's field, Stormont Cirrus, a variety from northern Ireland, yielded about 25 percent more than J. W. S., the leading variety grown in Oregon in recent years.

Selections were tested for disease resistance, especially to flax rust and flax wilt, at Astoria, Oreg.

Samples of scutched fiber from 160 varieties were subjected to hackling tests in a linen mill at Salem, Oreg. The yields of dressed or hackled fiber ranged from about 77 to 87 percent of the original weight of scutched fiber, whereas most of the imported Russian flax yields less than 60 percent.

In further tests on different soil types, the Chehalis series produced the best results, as in the preceding year. Well-drained and fertile soils of the Willamette and Amity series gave good results, and poorly drained soils of the Wapato and Dayton series produced poor flax. Nitrogenous fertilizers increased the yield and apparently did not injure the quality or the tensile strength of the fiber.

Strong claims having been made that retting flax by means of sea-kelp soap was much superior to any process now in use, a careful test was made at the experimental flax mill. This test demonstrated very definitely not only that soap retting is much more expensive than warm-water retting but that it is practically impossible to produce a satisfactory fiber from soap-retted flax straw.

Fiber flax grown at the New Jersey and New York (Cornell) Stations, while equal in quality to much of that imported, was inferior in both yield and quality to that produced in Oregon.

The Bureau has endeavored to counteract the misleading statements of promoters with various schemes for obtaining funds from farmers or from the Government to develop a fiber flax industry by methods not yet demonstrated.

DIVISION OF DRUG AND RELATED PLANTS

W. W. Stockberger, *in Charge*

The revival of hop growing following the repeal of prohibition has called for increased attention to this crop, and the Division has also endeavored to meet the unusual demands from individuals and from some of the new Government organizations for information and advice regarding plants yielding drugs.

essential oils, perfumes, and related products, in the general search for new crops having commercial possibilities. The policy has been not to encourage the growing of these special crops except where they are reasonably promising.

HOPS

A promising beginning has been made on a project to determine factors affecting the quality of hops, with a view to improving the quality of American hops as a means of meeting the competition of the foreign-grown hops that are imported in considerable quantities. By analyses of many samples obtained under controlled conditions with respect to harvesting, drying, and baling, it is believed that improved practices may be formulated that will result in better quality and increased prices. Hops are grown mainly in the Pacific Coast States and in New York.

Downy mildew, a disease which is a constant threat to the hop-growing industry in Oregon and Washington, has been a subject of continued study in cooperation with the Oregon station. Two methods are being followed, namely, field practices to control the disease, and the development of resistant varieties. Field practices found to be reasonably effective are (1) clean culture and the removal of old vines from the field in the fall; (2) application of fungicide dusts to the crowns; (3) removal of the infected growth (spikes) from the crowns in the spring; and (4) spraying vines with bordeaux mixture. The hop-breeding experiments are designed to develop a high-quality, high-yielding variety resistant to downy mildew. Thousands of hybrid seedlings, selections, and introductions have been grown, and several promising sorts are being further tested to prove their commercial value before making them available to growers.

INSECTICIDAL PLANTS

In the search for insecticides harmless to human health, to replace poisonous chemicals such as arsenic and lead and thereby remove any possible danger from spray residues on fruits and vegetables, the Bureau is studying plants containing insecticidal substances. Through the Division of Plant Exploration and Introduction, derris and cube plants have been obtained from the Tropics and other plants with insecticidal properties are being sought.

The Division of Drug and Related Plants is making a survey and study of the native plant known as devil's shoestring (*Cracca virginiana*), the root of which in some localities contains rotenone and probably other toxic substances, with the objects of determining in what regions the plant is toxic and what conditions of soil or climate cause the toxicity, and working out cultural methods for high content of insecticidal substances.

Studies and tests of pyrethrum have been continued. This plant is being grown experimentally in a number of places, and efforts are being made to develop a more toxic type by selection. Business interests have introduced it as a commercial crop in Pennsylvania, and it seems adapted to the other sections. Experiments were carried on at the Arlington Experiment Farm (near Washington, D. C.), to test the feasibility of using mechanical means for harvesting and threshing the crop.

Experiments are also being conducted by the Division of Tobacco and Plant Nutrition in developing types of tobacco of high nicotine content for insecticidal purposes.

OIL, DRUG, AND PERFUMERY PLANTS

Safflower.—The possibilities of growing safflower in the northern Great Plains as a source of drying oil to augment the insufficient supply of linseed oil are being tested in a practical way. Three acres of the crop were grown at the Bureau's stations at Huntley, Mont., and Newell, S. Dak., to maintain a seed supply of special varieties of Russian safflower high in oil content. Safflower has proved to be more resistant to drought than some of the crops generally grown in that region.

Japanese mint.—A report on the completed investigation of the possibilities of growing Japanese mint in the United States as a source of natural menthol was made available during the year by the publication of Technical Bulletin 378.

Perfumery plants.—Experiments in growing lavender for the production of lavender oil, of which several hundred thousand pounds are imported annually, have given encouraging results in the Puget Sound area. Oil from experi-

mental plantings is of acceptable quality. Yields, production costs, and methods of harvesting with machinery to reduce labor costs are being studied.

Attar of rose has been the subject of numerous inquiries. Incomplete experiments in cooperation with the Oregon station, discontinued for lack of funds, indicate that the yield of perfume from the variety of rose tested (Ulrich Brunner) is lower than in France, the quality is only fair, and the cost of production is too high. It is possible that more favorable results could be obtained in other regions having a different climate and lower labor costs.

DIVISION OF DRY LAND AGRICULTURE

C. E. Leighty, *in Charge*

The investigations in dry-land agriculture, conducted at 19 field stations in the semiarid region in cooperation with State experiment stations, are directed to basic problems of that region, and the results are of local, regional, and even world-wide application. About 5,000 plots are used in crop rotation and cultivation experiments with about 25 crops. Studies are made to determine the best methods of conserving and utilizing the limited rainfall, what crops and varieties to grow, how best to manage pastures, where it is safe to farm and where not, and other problems of dry-land farming. The large body of data assembled is useful not only to farmers but to officials engaged in classifying land, and will certainly be of further use if land purchases are undertaken in this region or if any general changes in the use of the land are made. Two projects—shelter belts and pasture management—are of timely interest in the national program of agricultural readjustment.

SHELTER BELTS

High winds are the rule in the entire Great Plains area, and farm homes, gardens, and orchards require protection. To provide this protection, the stations at Mandan, N.Dak., Cheyenne, Wyo., and Woodward, Okla., have undertaken wide demonstrations of shelter-belt plantings. Some of the hardy trees such as green ash, boxelder, Chinese elm, Siberian pea-tree (caragana), Russian-olive, northwest poplar, and evergreens have been furnished to cooperating farmers who plant and tend them under station supervision. About 3,000 farmers are cooperating with the stations in growing these shelter belts, and more than 5 million trees have been put out. Many of these cooperators have planted fruit and vegetable gardens in connection with their shelter belts. The effect of the shelter belt on the garden has been pronounced, especially when contrasted with gardens grown in the open. In dry years the majority of the dry-land gardens that survive are those protected by shelter belts.

The season of 1933 offered many opportunities both at the stations and on farms for comparison of the drought-resisting abilities of the different conifer species that are generally recommended for the northern Great Plains. Western yellow or ponderosa pine is outstanding in its ability to thrive under adverse moisture conditions. Scotch pine, which in the past has generally been considered absolutely hardy, suffered both killing back of leader growth and losses in stand. White spruce and Black Hills and Colorado blue spruces were rapidly turning brown and dying as a result of the drought. The losses in spruce are confined chiefly to trees in southern and western border rows of shelter belts. A hardiness rating on evergreens at the present time would undoubtedly place western yellow pine at the head of the list, followed by red cedar, the three spruces, Scotch pine, Norway pine, and jack pine.

PASTURES

It has been found at the Mandan, N. Dak., station that although a rather large number of species of plants grow on the prairies of the northern Plains only 25 or 30 of them are important to grazing, and 4 of these produce about half the forage. By experiments in cooperation with the North Dakota station it has been shown that 7 acres under a system of continuous grazing will support a steer for 5 months and produce a gain of 300 pounds. By following a system of deferred and rotation grazing the area can be reduced to 5 acres with a gain of 275 pounds and the pastures will be maintained in better condition in respect to the desirable species. It has been found, too, that with

B. P. I.—229.

THE DRUG KNOWN AS PINKROOT.

INTRODUCTION.

The drug known as pinkroot is derived from the underground portions of *Spigelia marilandica* L. (Pl. I), an American herb now found growing most abundantly in the Southern States and occurring locally in the Mississippi Valley and eastward. It came into use in America as a vermifuge about 1723 and because of its valuable properties soon came to occupy an important place in materia medica. Unfortunately, however, conflicting reports on its physiological effects in time established for pinkroot a reputation for uncertain action, and within the last fifty years the use of this drug, once regarded as highly reliable and valuable, has greatly decreased. Since it has seldom been held at high prices the cost has not operated to drive it out of the markets.

The cause of the apparent loss of high efficiency formerly claimed for pinkroot has engaged the attention of students of crude drugs for many years. The demonstration by Dr. R. H. True[a] that an unsuspected substitute had crept into the markets and to a considerable degree replaced the true article has explained in large measure the unfavorable commercial and medical status of pinkroot. The results here outlined of a detailed study of pinkroot and its more important adulterants may serve to aid collectors in discerning the real pinkroot and to assist drug experts in distinguishing the plant from its sophistications in its commercial form.

TRADE VARIETIES OF PINKROOT.

The complex nature of the material put upon the market as pinkroot has long been known to the drug trade, and although the real nature of the spurious article was not understood, its presence was recognized, and various sorts of pinkroot came to be distinguished by definite trade names—e. g., true pinkroot, genuine pinkroot, southern pinkroot, Georgia pinkroot, East Tennessee pinkroot, western pinkroot, and true fiber pinkroot. The visible differences by which these trade varieties are segregated may be utilized in distinguishing

[a] Pharmaceutical Review, 21: 364, 1903.

the true from the false pinkroot, as it is now definitely known that certain of the trade varieties are wholly composed of worthless substitutes.

In many cases careless or unscrupulous collectors and dealers have not regarded the distinguishing features of the various sorts of pinkroot, or have been ignorant of them, with the result that very general confusion exists as to the character of the real drug and its adulterants. The authors of some prominent publications on crude drugs have evidently based their observations on trade varieties of pinkroot, as they have illustrated and described one of the most important adulterants as true pinkroot.

IDENTITY OF CHIEF SUBSTITUTES.

East Tennessee pinkroot (*Ruellia ciliosa* Pursh), a member of the plant family Acanthaceae, is the most important adulterant. Observations on the plant structures present in commercial samples of pinkroot convinced Dr. R. H. True, in 1900, that the chief part of this crude drug consisted of a substitute instead of Spigelia and that this substitute was a species of Ruellia. In trying to get plants of pinkroot for cultivation, Doctor True, in 1903, purchased several hundred roots from a dealer in eastern Tennessee. These roots were set out in the testing gardens of the Bureau of Plant Industry at Washington, D. C., and the plants kept under close observation. On developing they were found to differ markedly from Spigelia, and upon flowering were identified as *Ruellia ciliosa* (Pl. II), a plant which had never appeared in the list of suspected adulterants prior to this time.

The examination of the microscopic structure of this plant recalled at once the figures in some text-books purporting to represent Spigelia and those illustrating an article by Greenish in the Pharmaceutical Journal, 1891, on the structure of *Phlox carolina*, a plant which had long been regarded as an extensive substitute for pinkroot. It was evident that a double confusion existed with regard to Ruellia. On the one hand it was so widely mistaken for Spigelia that its peculiar structures have been regarded as diagnostic of pinkroot, and on the other it was recognized as a substitute, but wrongly regarded as Phlox, a plant lacking many of the striking characteristics of Ruellia.

In order to satisfactorily determine the relation of these substitutions to the true pinkroot, observations have for three years been made upon plants of Spigelia, Ruellia, and Phlox under cultivation at Washington, D. C., and fresh material secured from them has been used in making a comparative study of their structure. The results of this study do not support the view that Phlox is an adulterant of pinkroot, and, moreover, several samples of a substitution supposed to be Phlox have proved, upon examination, to be composed entirely of Ruellia. It is only through long and familiar observation in the

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PINKROOT (SPIGELIA MARILANDICA L.).

EAST TENNESSEE PINKROOT (RUELLIA CILIOSA PURSH).

living condition of all species here concerned that it has been practicable to uncover fully the true relations involved in the drug called pinkroot.

MINOR ADULTERANTS.

Aside from Ruellia the adulterants of Spigelia may be regarded as impurities, due in the main either to the carelessness of the collector in not sorting out the roots with which the plant was associated in its growth, or perhaps to a lack of familiarity with the plant on the part of young or inexperienced collectors. With Spigelia other roots sometimes occur which have a greater market value than the true pinkroot, and therefore can not be regarded as intentional adulterants. The worthless roots frequently present, however, may have been introduced by the collector with full knowledge that a fraud was being perpetrated. In commercial samples of pinkroot, among other impurities have been observed roots of golden seal (*Hydrastis canadensis* L.), serpentaria (*Aristolochia serpentaria* L.), soapwort (*Saponaria officinalis* L.), wild yam (*Dioscorea villosa* L.), and stoneroot (*Collinsonia canadensis* L.).

METHODS OF DISTINGUISHING PINKROOT FROM ITS SUBSTITUTES.

Once familiar with the true pinkroot it is hard to see how any drug collector could confuse it with the plants so frequently substituted in its place. Spigelia and Ruellia grow over large areas, largely overlapping and in much the same habitat, and have on the whole a certain general resemblance; but they should be readily distinguished by observing any one of their several striking characteristics.

In Ruellia (Pl. II) the flowers are borne scatteringly along the stem in the axils of the leaves; in Spigelia (Pl. I) they are aggregated at the top of the plant in a one-sided spike. In Ruellia the pale magenta-colored corolla forms a slender tube below, expanded upward into a broad, flaring limb. The anthers and style are not protruded. In Spigelia the corolla forms a rather broad tube, narrowest at the throat, prolonged upward into spreading, narrow, triangular portions. The exterior is brilliant cardinal in color, bright yellow on the inside; the style and anthers are exserted. The leaves of Ruellia are bright green, usually short-petioled or sessile, frequently more or less hairy. In Spigelia they are dark green, glossy, and sessile.

In the crude drug the forms are separated by less evident gross characters. Ruellia, however, has a coarser, harsher root system than Spigelia, and the roots show a tendency to lose the cortical tissues, leaving the naked, woody cylinder exposed. The roots of Spigelia are delicate, fibrous, and usually very numerous. When dry they break and crumble very readily.

The difference in structure between Spigelia and its substitutions as seen under the microscope are usually very marked. This is especially true of Ruellia, the only important adulterant found with Spigelia, since the other plant parts sometimes present are usually recognized by their gross characters. A comparison of figures 1 and 2 will show the most important differences in minute structure. The numerous cystoliths present in Ruellia as a very conspicuous feature are wholly lacking in Spigelia and *Phlox ovata.* The large sclereids of the root of Ruellia are not found in the other two plants, and starch, which is present in Spigelia, is absent in both Ruellia and Phlox.

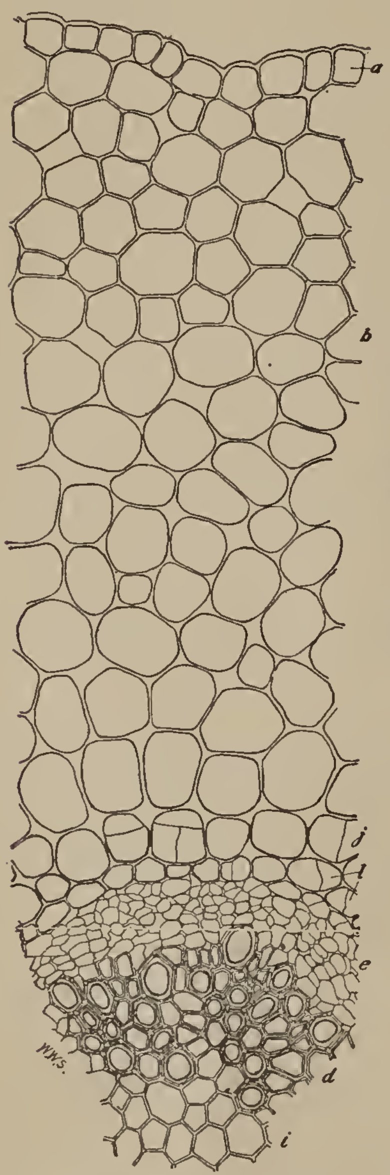

FIG. 1. Cross section of root of *Spigelia marilandica* L.: *a*, epidermis; *b*, cortex; *d*, xylem; *e*, cambium; *i*, pith; *j*, endodermis; *l*, pericycle. ×180.

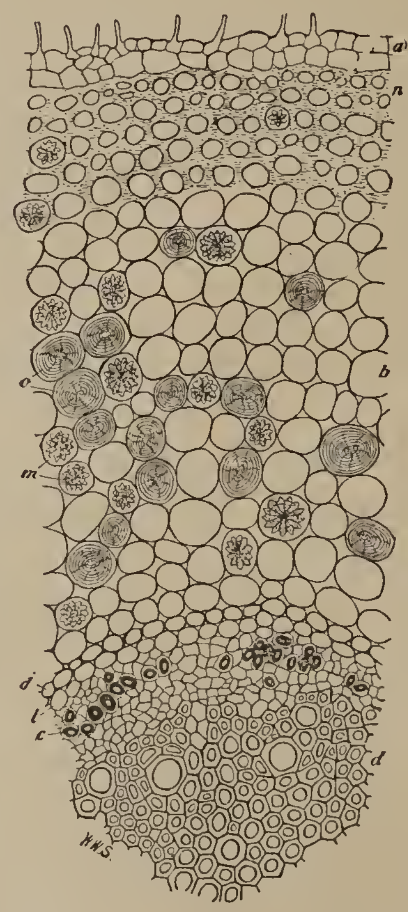

FIG. 2. Cross section of the root of *Ruellia ciliosa* Pursh.: *a*, epidermis; *b*, cortex; *c*, bast fibers; *d*, xylem; *j*, endodermis; *l*, pericycle; *m*, cystoliths; *n*, collenchyma; *o*, sclereids. ×150.

In the powdered form Ruellia always reveals its presence by the numerous stone cells and cystoliths, which usually remain intact even in finely powdered material. Powdered samples of the underground portions of the Phlox at hand gave no reaction for starch. The fineness of the starch grain of Spigelia and its lack of striking characters render uncertain its identification among many other plant starches which might be readily introduced in the powdered drug. The starch grains of Spigelia measure about 4 μ, and in powdered pinkroot are associated with parenchyma cells and long light-colored sclerenchyma fibers. The absence of starch from a powder supposedly made of pinkroot suggests at once that the material is not Spigelia. On the other hand, the presence of starch, while indicative of Spigelia, is by no means conclusive proof of its presence.

DRUG-PLANT CULTURE IN 1916.*

BY W. W. STOCKBERGER.[1]

During the past two or three years, the production of literature on the cultivation of medicinal plants has proceeded with what may well be called a breathless rush, and while we are as yet far from being certain that our feet are on firm ground, nevertheless it is highly desirable at this time that we pause for a while to consider well the direction in which we are so rapidly moving. It is possible, even probable, that unexpected or unconsidered difficulties will be encountered at no great distance ahead. The enthusiasm and optimism responsible for the tremendous wave of interest in drug-plant culture which has indeed gone around the world has for the most part stifled the voices of those who would inquire more thoroughly into the economic aspects of drug-growing before attempting to engage therein on a commercial scale. The shortage in botanic drugs with the corresponding sharp advance in prices which we have all noted during the past two years has apparently been accepted widely as an indication that the requirements for these materials are practically unlimited, that the supply can never overtake the demand, and that the present inflated prices will not decline from their present levels at least for a long time to come. Although the total output of medicinal plants represents but a very small fraction of the world's commerce in agricultural products, I will hazard the statement with little fear of contradiction that there has been more excitement and enthusiasm manifested about the cultivation of medicinal plants than there has with regard to many other economic products, the value of which exceeded by many times that of our botanic drugs and for which the world's necessity is at least equally great. In the United States, the profits to be realized from the cultivation of medicinal plants has been a favorite theme, both from the platform and in the pharmaceutical press. Abroad, patriotic motives have led individuals to go even further, and as a result the cultivation of medicinal herbs has been undertaken in a number of countries both by individuals and by associations formed for that specific purpose. Among these may be mentioned the Society of the United Irishwomen, The Herb-growing Associations, in England, and The Medicinal Plants Board in Australia.

It is gratifying to note that evidence of returning sanity as regards the drug-plant situation is now accumulating on every hand. From a recent writer[2] in *The Pharmaceutical Journal and Pharmacist,* I quote:

"The enthusiasm of the herb-growing sisterhood is really getting almost a nuisance. A friend of mine who occasionally writes for the press tells me that in a thoughtless moment he gave his printed blessing to this movement, since when rarely a day passes but he has occasion to repent him of his vanity. From all parts of the British Isles he is the regular recipient of letters from patriots who took him too seriously. Medicinal herb-growing is no amateur's pastime, and much disappointment is bound to meet those who think it is. I am told that merchants have been offered a few pounds of newly collected dandelion roots at 105s. a cwt. I should be sorry to say anything to discourage the praiseworthy intentions of that vast if scattered community of ladies and gentlemen who think

*Read before Scientific Section, A.Ph.A. Atlantic City Meeting, 1916.

[1] Physiologist in Charge of Drug-Plant and Poisonous-Plant Investigations, Bureau of Plant Industry, United States Department of Agriculture.

[2] *The Pharmaceutical Journal and Pharmacist,* vol. 96, p. 645, June 24, 1916.

they can help their country by turning their strawberry beds into foxglove plantations, but really someone ought to tell them they are on the wrong track. Occasionally one gets a gleam of common sense through the great black cloud of ignorance."

Another writer,[3] in the *Chemist and Druggist*, expresses much the same idea as follows:

The Cultivation of Medicinal Plants.

"This appears to be catching on as the very latest hobby for ladies who have not been able to find any outlet for their energies in the usual (war) channels. I use the term "hobby" advisedly, for I am quite sure that of every hundred people who take up plant cultivation and gathering at least ninety-nine will drop it long before it comes to be a paying proposition. It appears that not only in this

Fig. 1.—General view of the medicinal plant garden, College of Pharmacy, University of Nebraska.

country, but in some allied countries, societies are being started for the promotion of this subject, and where there is behind the promoters sufficient capital to ensure a few years of labour without any remuneration there is the possibility that some profit will by and by be made in the undertaking. At the best, however, it must be a case of casting their bread upon the waters with little hope that it will come back after many days, much less come back 'buttered too, for certain,' as Biglow's Pious Editor phrased it. The isolated, spasmodic efforts now being made throughout the country by people, themselves unacquainted with plant-farming, and depending for their information on experts, are hardly likely to add much to the sum total of drugs cultivated in Great Britain."

Prof. J. H. Maiden,[4] the veteran Government Botanist of Australia, in a recent discussion of the cultivation of drug-plants, insisted on great caution in this enterprise and emphasized the fact that "the drug industry is highly technical and the willing man with land must not be encouraged to engage in it until he has acquired the necessary culture knowledge and has suitable land well situated as regards climatic conditions and transport." Prof. Maiden rightly points out the danger of over-production in certain lines and urges the great desirability of a thorough organization of the industry in order that time, money and labor may not be use-

[3] *The Chemist and Druggist*, vol. 88, p. 41, July 8, 1916.

[4] *Botanical Gazette of New South Wales*, vol. 28, p. 134, 1906.

lessly expended in attempting to produce materials in competition with other lands which have a positive advantage owing to their favorable conditions of production or cheaper technical labor involved than in many of the processes of producing botanic drugs.

In this country, there is a growing recognition of the fact that prospective drug growers have derived many false ideas from the numerous well-meaning but over-sanguine newspaper and magazine articles recommending drug culture as a sure and easy means to large and certain profits. However, among those who have given the matter the most careful consideration the opinion is quite general that a successful and permanent drug-growing industry in the United States cannot be built up along the lines which have been so widely recommended. There is, of course, ample opportunity for those who would grow drugs not for profit, but for patriotic, philanthropic or sentimental reasons, but as a purely commercial proposition drug-growing presents fully as many difficulties as any other specialized crop in the realm either of agriculture or horticulture. It is well to reiterate the statement which I have frequently made in other connections that the growing of drug-plants offers little promise as a side crop for general farmers and that conditions in this country are far more favorable to this enterprise if entered into only by well equipped growers who do not need to depend for their livelihood upon this industry, and who have sufficient capital at their command to enable them properly to equip and maintain the enterprise until it can be put upon a paying basis.

At the meeting of this Association held at Detroit, in 1914, I presented before the Scientific Section a paper on medicinal plants in which a differentiation was made between medicinal plant gardens which are industrial and those which are pedagogic in their functions and uses. The industrial garden was defined as one, "the object of which is to give additional information concerning our agricultural resources." It is gratifying to know that since the writing of that paper there has been a substantial and I trust a permanent increase in the public interest in gardens of this character. In addition to the several industrial drug gardens now maintained by the Bureau of Plant Industry in different portions of the United States, there have been developed by several well-known pharmaceutical manufacturers highly creditable industrial gardens which are not only yielding information with respect to the economics of drug-plant production, but which are also supplying in part the manufacturer's requirements for certain crude botanic drugs.

Occasions are conceivable which might excuse an indulgence in glittering generalities with regard to these gardens and there is no gainsaying the fact that as a rule an optimistic or rosy discussion of drug-growing meets with a more ready and appreciative acceptance than is accorded to a conservative statement which directs attention to the risks and drawbacks which will be encountered and consider only material which is well within the realm of fact. Artistic pictures and word-paintings are all very well as a means of stimulating interest in the subject but the mere desire to be interesting should induce no one to place himself in the questionable position of prevailing upon a fellowman to invest his time and money in an enterprise with the expectation of deriving profit therefrom unless he can produce concrete data to show conclusively that such profits may be expected with reasonable certainty. To repeat a pertinent illustration used on a former occasion, let me recall the statements of a writer in one of our well-known pharmaceutical journals who recommended the castor bean as a profitable crop "on rocky and otherwise unprofitable land, on hillsides or

arid desert soil" in the Southwestern States. With charming naivete this same writer later made the admission that he had no personal knowledge whatever of agricultural conditions in the Southwest. A contributor to a recent number of our own A. Ph. A. Journal has also made some surprising recommendations with regard to this same castor oil plant. Both of these writers apparently entirely overlooked the fact that the existence of a demand for a commodity is not necessarily an indication that it is a commercial possibility in this country. The market requirement may be large, and the price apparently attractive, but other factors, among which may be mentioned the price of land, cost of labor, competing crops, and transportation, enter so largely into the commercial aspect of the question that they practically determine whether or not the crop is a commercial possibility.

It would seem therefore that there exists at present a great need for the mul-

Fig. 2.—General view of the medicinal plant garden, College of Pharmacy, University of Minnesota.

tiplication of the industrial type of medicinal plant garden in order that there may be obtained in various sections of the country dependable data on the commercial phase of drug-growing. It should be obvious to everyone that such data to have any practical value must be acquired under practical commercial conditions.

During the past two years, there has been a marked increase of interest in the pedagogic garden, the characteristics and functions of which I have elsewhere discussed.[5] The number of educational institutions which maintain medicinal plant gardens in connection with their courses in pharmacy is rapidly increasing. Among these may be mentioned the Universities of Michigan, Minnesota, Nebraska, Wisconsin and Washington. Similar gardens are also maintained at Purdue, Grinnell, and the State Colleges of South Dakota and Washington. The establishment and proper support of a medicinal plant garden of the pedagogic type as an adjunct to a college of pharmacy or the course in pharmacognosy of a university should be of direct and practical benefit to the students, to the university itself, and finally to the people as a whole. The students should profit from such an enterprise largely from the fact that they can be brought into direct contact with medicinal plants which are in a living state, and learn at first

[5] Journal of the American Pharmaceutical Association, 3: 1436–1440, 1914.

hand the processes through which material obtained from the fresh plant must pass before it becomes the finished product. They will thus gain a broader and more comprehensive basis on which to develop in them an appreciation of the necessity for a high standard of purity in crude drugs and they will also acquire information with respect to opportunities for sophistication or impairment of quality through faulty methods of preparation and handling and hence become better prepared to exercise the care and judgment necessary in the selection and use of crude drug products. Their interest in and appreciation of Materia Medica likewise will receive a great stimulus through their contact in an objective way with crude drugs during their course of preparation. Very important to the students also will be the thorough grounding in the economics of the crude drug trade which they will receive through the proper course of instruction which

FIG. 3.—Interior view of the medicinal plant laboratory, College of Pharmacy, University of Minnesota.

can be given in connection with a pedagogic garden. The student who will make a careful record of the expenditure of labor (preferably his own) necessary to produce a given quantity of drug and then after marketing the same deducts from the returns a fair allowance for his work, will not be likely to become infected with the erroneous ideas now only too prevalent concerning the enormous profits to be derived from the production of medicinal plants.

To the University the medicinal plant garden is an invaluable aid and resource in teaching materia medica, pharmacy, pharmacognosy, botany and forestry. The pedagogic garden will furnish much of the living material necessary for the first year's work in botany, and in the pharmacy school the double purpose will be served by using medicinal plants as working materials in the teaching of morphology and general plant histology. The pedagogic garden also affords the student the means for pursuing the study of the production of the actual drugs in the field and the methods of their collection and preparation. The supply of

living plants which can be obtained from the garden will greatly extend the opportunity for research work on the part of advanced students of pharmacy. Most of the specifications regarding time and method of collecting, curing and preserving crude drugs are based on tradition, and not on scientific experiment, and the determination of the relative value of our present requirements with respect to the preparation of botanic drugs affords an almost limitless field for research. In another direction also the study of the variation of the active principle among different species of a genus, or even among individuals of the same species, affords

Fig. 4.—Digitalis and hyoscyamus seedlings in medicinal plant laboratory, College of Pharmacy, University of Minnesota.

great possibilities. The work on belladonna now being conducted by the Bureau of Plant Industry is an illustration of this type of research, opportunities for which are practically without number and many of which may easily be made evident to the student through the proper use of the medicinal plant garden. By this means not only will the effectiveness of the teaching be increased, but the interest and appreciation of the students in this line of work will be aroused and held, results both of which are quite in harmony with the higher interests of the University.

To the people as a whole, the establishment and maintenance of the pedagogic drug garden in connection with our institutions of learning are of direct value in many ways, only a few of which there is now time to mention. It will furnish

information regarding the medicinal plants which are adapted for cultivation in the particular locality in which the garden is located, and thus in time provide a fund of information of permanent value to the agricultural population of the region. Such information will be of especial value in the immediate future, since the necessity for a wider diversification of the agriculture of many localities is receiving increased recognition and further since for large areas there exists practically no reliable data regarding the agricultural possibilities for medicinal plant culture. The pedagogic garden properly directed will perhaps lead to the development of the larger, and in some respects more important industrial gardens which in turn may point the way to new agricultural industries. Although these industries may be relatively small as compared with staple crops, yet they will con-

A COMMERCIAL TEST AND BREEDING PLOT OF BELLADONNA.

tribute to a more diversified agriculture and afford opportunities for an individual here and there to add to his income or better to ultilize the agricultural facilities which they already possess. By more widely diffusing knowledge respecting medicinal plants, the pedagogic garden should lead to a fuller utilization of the natural resources of the country, and should be the means not only of training students who are to be pharmacists along these lines, but also of arousing a wider interest in these resources, and in the dissemination of knowledge regarding them and their inherent possibilities. If the garden is conducted on a sufficiently large scale, it will furnish data on the production of drug-plants which when properly prepared and disseminated will safeguard the people of the country from loss through ill-considered ventures in drug-plant cultivation. The country is now full of talk about the enormous profits to be made from the growing of medicinal plants, all of which means nothing if it cannot be supported by positive concrete evidence of profits realized or material advantage to be gained. It is to be hoped

that the work of the pedagogic and industrial drug gardens will continue to develop hand in hand and that by means of the trustworthy data acquired from each, the commercial production of botanic drugs in the United States may be placed upon a sound basis, the quality of drugs of this class be increased, and a general good result to our people as a whole.

DISCUSSION

R. A. LYMAN: Just a word about the Drug-Plant Garden work. I think this subject is very important at the present time. I know of a number of instances where there was considerable difficulty in making the officials of the institutions which they represent become interested in the drug-plant garden for teaching purposes. Many think it is useless. I had that condition to meet in Nebraska, but in the course of two or three years the drug-plant garden has become one of the most interesting points in the city of Lincoln, and I find it is being advertised, not only on the campus, but by the leading commercial club and I find reference to it in the leading newspapers of the State. It has given the people a very different idea of pharmacy: because of the fact that the war has so influenced the importation of crude drugs, the attention of the people has been called to the necessity of getting an adequate supply of crude drugs, and the war has helped this matter very greatly.

I look at it from an entirely educational standpoint just at the present time. The Regents of our institutions understand that it takes money to establish a laboratory, and I look upon the drug-plant garden as a laboratory. They would not think anything of paying seventy-five to a hundred thousand dollars for a laboratory to do a certain thing, and it should be put up to them that a drug-plant garden represents a laboratory and has become a source of information where we can get things for the university and for the college of pharmacy which we cannot obtain in any other way.

Again, the drug-plant garden idea has been an inspiration to students and students have begun to think differently about the study of drugs. Many students go out from the university and start gardens in their home towns. I do not say that they will produce a great number of plants and largely increase the supply of drugs, but they are interested in the professional things of pharmacy. It interests them in research work, in that they are trying to produce things that were not produced before.

I want to personally thank Dr. Stockberger for his paper, and for the assistance he has given me in helping me to develop the garden at the University of Nebraska, not only by furnishing available material, but with the suggestions he has given me from time to time.

C. E. VANDERKLEED: By way of encouragement to schools of pharmacy, it was my privilege last year to pay a visit to the University of Berlin, and while they have beautiful laboratories, well equipped, what to me was the most impressive thing was the botanical garden covering acres, in which they were raising every plant—every medicinal plant—it was possible to raise in that climate. Dr. Thoms became quite enthusiastic in telling of its value to the student by being able to go out into that garden and collect a plant containing a sufficient amount of, say, volatile oil, take it into the laboratory and properly cure it and distil the volatile oil and obtain the finished pharmaceutical product, and there is no reason why our pharmaceutical schools should not have this same advantage for their students.

DRUG PLANTS UNDER CULTIVATION

By W. W. Stockberger, *Principal Physiologist in Charge, Drug and Related Plants, Bureau of Plant Industry*

CONTENTS

PRODUCTION OF CRUDE DRUGS

Interest in the possibility of deriving profit from the growing of drug plants continues from year to year. The clearing of forests, the extension of the areas of land under tillage, and the activities of drug collectors threaten the extermination of a number of valuable native drug plants. Annually, large sums of money are expended for crude drugs imported from countries where they are grown under conditions of soil and climate resembling those of many localities in the United States. As a means of guaranteeing the future supply of crude drugs and of lessening the dependence on importations, the cultivation of drug plants should receive continued attention and encouragement whenever circumstances indicate that such an undertaking might be attended with success.

The problems presented by the cultivation of drug plants are not less difficult than those encountered in the production of many other crops. Drug plants are subject to the same diseases and risks as other crops and are similarly affected by variations in soil and climatic conditions. They require a considerable outlay of labor, the same as other crops, and likewise require intelligent care and handling. They are subject to the same laws of supply and demand, and, like other products, must conform to the consumer's fancy and to definite trade requirements.

A number of common medicinal plants have long been cultivated in gardens of this country, either as ornamentals or as a source of herbs used in cookery and as domestic remedies. A few of these plants, such as goldenseal, wormwood, wormseed, and peppermint, have been grown commercially for sale as crude drugs; but the acreage devoted to their production has been relatively small and for the most part restricted to certain localities. Other drug plants which occur as common weeds in many places may prove to respond to cultivation; experiments should then be undertaken to determine whether it is profitable to grow them. In this connection it should be

remembered that the soil type very often is an important limiting factor in propagating different kinds of plants. Some plants grow best in well-drained loam, some prefer a marsh, some require soils rich in lime, while others thrive only in acid soil. The soil requirements of all plants are not understood; in fact it is not improbable that better comprehension of the soil, climatic, and cultural conditions adapted to the different kinds of plants will enable the successful propagation of species now regarded as unsuited to cultivation. In undertaking the growing of medicinal plants, therefore, it is essential to know that the species selected for cultivation will do well under the conditions of soil and climate existing where the planting is to be made. When necessary, this should be determined on small experimental plots before undertaking commercial plantings.

Assuming that the soil and climate of the situation selected are suitable for the growing of drug plants, it does not necessarily follow that they can be produced at a profit. The cost of production and marketing may be greater than the amount received for the crop when it is sold. Some drug plants not well suited for cultivation on a large scale may be found profitable when grown on small areas as a side line. On the other hand, some may be produced more cheaply when cultivated on a scale large enough to warrant the use of labor-saving devices than when grown on small areas with the aid of hand labor alone. The value of land, the cost and availability of labor, and the possible returns from other crops are all factors to be considered carefully. On account of the variation in these factors according to locality, the same crop might prove to be profitable in one location and unprofitable in another. It is for these reasons that unqualified statements concerning the ease and profitableness of drug-plant growing should not be taken too seriously.

SOME DRUG PLANTS SUITABLE FOR CULTIVATION IN THE UNITED STATES

The number of drug plants which may be grown in the United States is large, although the same plants are not equally adapted to the conditions of soil and climate prevailing in different sections. Often the most suitable plants for a particular locality can not be foretold, especially in those situations where no attempts have yet been made to grow them. In such cases it is well to select for cultivation plants which thrive elsewhere under conditions most closely resembling those of the new situation in which it is proposed to grow them. The success with which ordinary field or garden crops can be grown will in general indicate the possible suitability of a given location for growing many medicinal plants. Since a number of native medicinal plants which in their wild state are restricted to certain localities have been successfully cultivated in situations far beyond their natural range, there are good reasons for believing that many such plants will thrive in sections where they are not now grown. However, good results can scarcely be expected unless the plants are placed under conditions similar to those in which they normally thrive.

In suitable soil and under favorable weather conditions the following drug plants have been found to thrive well under cultivation in numerous places in the Central and Eastern States and will probably

be found suitable for cultivation in many other situations [illegible]e difference in climatic conditions is not too great:

Anise.	Conium.	Elecampane.	Sage.
Belladonna.	Coriander.	Fennel.	Stramonium.
Camomile.	Digitalis.	Henbane.	Tansy.
Caraway.	Dill.	Horehound.	Thyme.

Some perennials, such as belladonna and digitalis, are only partly hardy and would be subject to winterkilling in the colder sections. Such plants as aconite, arnica, lovage, poppy, seneca, valerian, and wormwood seem to thrive best in the northern half of the United States in situations where the rainfall is well distributed throughout the growing season. On the other hand, licorice and wormseed are better suited to the warmer climate of the southern

FIG. 1.—Lath shed affording partial shade, especially well suited for growing woodland plants

half of the United States. Aletris, althaea, angelica, calamus, orris, pinkroot, peppermint, spearmint, and serpentaria are adapted generally for situations in which the soil is rich and moist, but lavender and larkspur are partial to well-drained sandy soil. Ginseng and goldenseal occur naturally on rich soil in the partial shade of forest trees and can be cultivated successfully only when planted in woodlands or in specially prepared soil under artificial shade (fig. 1).

GENERAL CULTURAL SUGGESTIONS

The special details of cultivation for each of the medicinal plants mentioned are given under the discussion of the individual species. Suggestions which are of general application, however, are here brought together, in order to avoid unnecessary duplication.

PROPAGATION

A number of the species considered later can be grown easily from seed, but others are best propagated from cuttings or by division. Many wild medicinal plants are much more difficult to propagate from seeds than are the species commonly grown in gardens. Likewise, some of the species now grown abroad and suitable for cultivation in this country are not easily propagated and require special conditions if good results are to be realized.

Seeds of the better-known varieties of medicinal plants are regularly listed in the catalogues of numerous seed houses, and those which are less common can usually be obtained from dealers who make a specialty of one or more of these species. Plants can frequently be obtained from nurseries or from dealers in hardy ornamentals. The catalogues of a number of dealers should be consulted and the varieties for propagation carefully selected. In ordering, the medicinal variety should always be called for, since many of the related ornamental forms which are listed are of doubtful, if any, medicinal value.

SOWING THE SEED

A relatively small number of medicinal plants can be satisfactorily grown from seed sown in the field. In many cases this method is quite uncertain, and with some plants wholly inadvisable. In order to insure a good stand of thrifty plants it is frequently necessary to make the sowings in a greenhouse, hotbed, or coldframe and at a suitable time transplant the seedlings to the field. Much information on seed germination, hotbeds, and coldframes can be gained by consulting Farmers' Bulletins 1673 and 1044, entitled, respectively, "The Farm Garden" and "The City Home Garden."

The preparation of the soil is of prime importance, whether the sowing of the seed is made in the open or under cover. Many seeds, especially those which are very small, do not germinate well in heavy soils or in those which are cloddy and coarse in texture. A seed bed prepared by thoroughly mixing equal parts of garden soil, leaf mold, well-rotted manure, and clean sand will be suitable for the germination of most seeds.

The depth of sowing is largely governed by the size of the seeds and the character of the soil. In general the smaller the seed the less the depth of sowing. Seed should be covered more deeply in light sandy soil than in heavy clay soil. Fall-sown seeds also require a greater depth of covering than those sown in the spring. The exact quantity of seed which should be used for sowing a given area can not be definitely stated. The same kind of seed will be found to vary widely in its power to germinate; hence, the percentage of germination should be ascertained in advance of sowing and the quantity regulated accordingly. In general the heavier the soil the larger the quantity of seed required. If the plants are to be thinned out or transplanted, or if they are especially subject to the attacks of insects, the free use of seed is usually advisable.

When plantings are made in open ground it is preferable to sow the seed in rows or drills, in order that cultivation of the soil may

be possible. A shallow furrow may be opened with a rake or wheel hoe and the seed sown by hand. The rake or hoe may then be used to cover the seed with the required depth of soil. It is much more satisfactory to use seed drills, such as are commonly used by market gardeners, than to sow by hand, since with the drill the depth of sowing is more uniform and the soil is compacted over the seeds, thus favoring good germination. The distance between the rows is determined in part by the size which the plants attain at maturity, but depends chiefly upon the method of cultivation to be used. A spacing of 9 to 16 inches between the rows will readily permit hand cultivation, but the rows should be about 3 feet apart if horse-drawn implements are employed.

CULTIVATION

There are no set rules for the cultivation of medicinal plants, and the grower's experience with other plants must be relied upon as a guide in many of the details of cultivation. As a general rule, the soil should be worked with the hoe or cultivator at frequent intervals and kept free from weeds. It is a good practice to cultivate after a hard rain as soon as the ground is sufficiently dry. During dry, hot weather loss of moisture from the soil will be diminished by frequent shallow cultivations.

HARVESTING

Drug roots are usually harvested in the fall or at the end of the growing season of the plant, but they may also be harvested early in the spring while still dormant. Roots collected during the growing season often shrink excessively in drying and so do not form the most desirable product. On small areas either a spade or a potato fork is a suitable tool for digging most roots; but if the area is large, labor will be saved by using a plow to turn out the roots, especially with such crops as belladonna or burdock. Most roots require thorough washing, and when the quantity is large this may be easily done if the roots are placed on a frame covered with wire mesh and water is applied by means of a garden hose.

All roots must be thoroughly dried. Large or fleshy roots are usually split or sliced, spread in thin layers on clean floors, and stirred or turned frequently. Good ventilation is essential, as several weeks usually elapse before the roots are dry enough to be stored with safety. The proper point of dryness is indicated when the roots break readily on being bent. The time of drying may be reduced to a few days by the use of artificial heat. For this purpose the walls of a well-inclosed room are fitted with racks or shelves to receive the roots, or large trays with bottoms made of slats or wire screen are suspended one above the other from the ceiling. The room is heated by a stove, and the temperature maintained between 125° and 150° F. Ventilators must be provided at the top of the room to carry away the moisture which is driven off from the roots. Ordinary fruit driers have been used successfully in drying roots on a small scale, but special drying houses or kilns will be necessary for successfully handling crops grown on an acreage basis.

Leaves and herbs are usually harvested when the plants are in flower. Picking the leaves by hand in the field is a slow process, and

time may be saved by cutting the entire plant and stripping the leaves after the plants have been brought in from the field. If the entire herb is wanted, it is preferable to top the plants, for if they are cut too close to the ground the herb will have to be picked over by hand and all the coarse stems removed. As a rule, leaves and herbs may be dried in the same manner as roots, but almost without exception they are dried without exposure to the sun, in order that the green color may be retained so far as possible. Information on the construction of drying houses is contained in Farmers' Bulletin 1231, "Drying Crude Drugs."

Some flowers are gathered while scarcely open and others as soon after opening as possible, and in general they should be carefully dried in the shade to prevent discoloration. Hand picking is very laborious, and mechanical devices similar to a cranberry scoop (fig. 2) or seed stripper (fig. 3) may often be used to good advantage. A homemade picker may be constructed as follows: From a stout wooden box, about 10 inches wide, 14 inches long, and 6 inches deep, remove one end and connect the opposite remaining sides at the top with a stout strip, which will serve as a handle. Drive long, slender wire nails through an inch strip of wood at quarter-inch intervals, thus forming a "comb" the teeth of which should be about 2 inches long. This comb is fastened to the bottom of the box in such a manner that the teeth will project outward through the opening left by the removed end. On swinging this device, teeth forward, through the flowers, the heads will be snapped off by the comb and will fall into the box, from which they may be emptied into suitable containers.

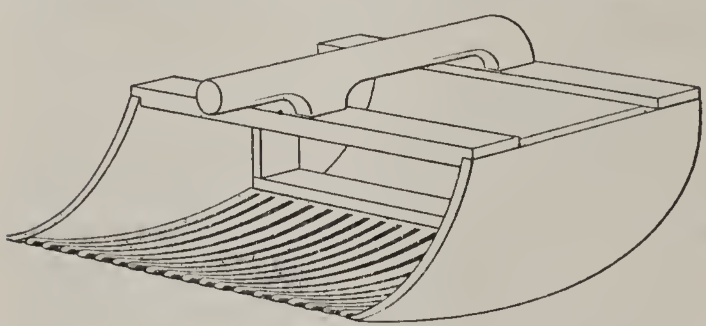

FIG. 2.—A berry scoop suitable for harvesting flower heads of large size

Seeds are harvested as soon as most of them have ripened and before the pods or seed capsules have opened. Seedlike fruits, such as anise, coriander, fennel, and wormseed, are harvested a little before they are fully ripe, in order that they may retain a bright, fresh appearance, which adds to their market value. The machinery used for threshing and cleaning ordinary seed crops will frequently serve a similar purpose for seeds of medicinal plants, provided the proper adjustments have been made. Most seeds must be spread out to dry and turned at intervals until thoroughly dried before they can be stored in quantity.

DISTILLATION

The volatile oil obtained from many aromatic plants by steam distillation is often their most valuable product. The equipment necessary for distilling volatile oils consists essentially of a steam boiler, a retort, and a condenser. A constant supply of cold water must also be available. A common type of retort consists of a circular wooden vat, about 6 feet in diameter and 8 to 10 feet deep (fig. 4), fitted with a removable cover, which can be made steam tight. Metal retorts

made of boiler iron three-sixteenths of an inch thick and jacketed with wood to prevent the radiation of heat are also used. A pipe leads from the steam boiler to the bottom of the retort and another from the top of the retort to the condenser, one form of which consists of a coil of tin-lined or galvanized-iron pipe inclosed in a jacket through which cold water is kept flowing when the still is in operation.

When the retort is filled with aromatic plants and steam is admitted through the pipe from the boiler, the volatile oil is extracted in the form of a vapor, which is carried over with the steam to the condenser, where both are condensed to liquid form. The oil and water together flow from the condenser into the receiver, one type of which is constructed like an ordinary milk can and is fitted with a siphon leading from the bottom, through which the water is drawn off to prevent the receiver from overflowing.

Many volatile oils will float on the water and may be drawn off from the top of the receiver at will. Other oils, such as sassafras and wintergreen, are heavier than water, and should be collected in a receiver provided at the bottom with an outlet tap through which the oil may be drawn off.

The cost of setting up a still will depend upon what facilities are already at hand and upon the size and efficiency of the apparatus installed. It may easily range from a small sum to several thousand dollars. The distillation of volatile oils from plants is described more fully in Farmers' Bulletin 1555, "Peppermint and Spearmint as Farm Crops."

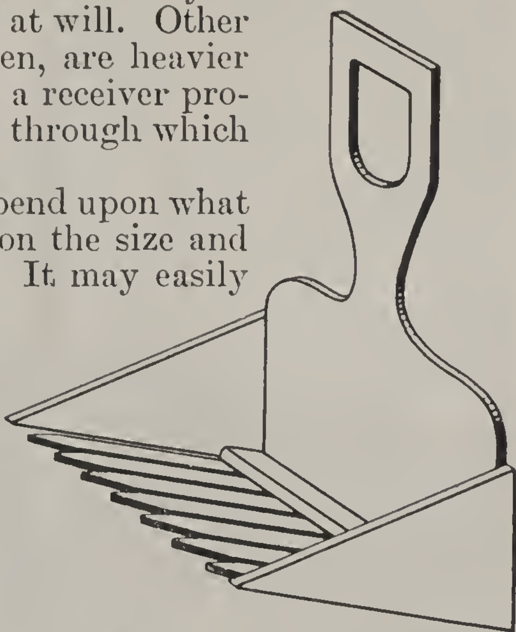

FIG. 3.—A seed stripper which may be used for gathering flower heads

YIELD

The yield that can be obtained from drug plants in different localities will naturally vary according to the suitability of the situation for the plants selected for cultivation. Even in the same locality wide variations in yield will result from differences in the lay of the land and in soil, drainage, and seasonal conditions. The skill of the grower and the degree of care and attention which he bestows upon his crop are also factors affecting yield.

Many of the drug plants mentioned in this bulletin have not been grown on a scale large enough to give a very satisfactory basis for calculating yields. Acreage yields calculated from the product of small garden plots are generally untrustworthy, since in such plots the plants are usually more favorably situated with respect to soil and are given better culture than when under field conditions. Moreover, as the area increases, it becomes more difficult to maintain an approximately perfect stand and to protect the crop from the ravages of insects or other destructive agencies. The returns from small experimental areas can at most be regarded as only an indication of the yield that may be expected under favorable conditions, and the prospective grower will do well to proceed cautiously until he has

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determined for himself the possibilities of yield in his particular location.

MARKETING

The commercial grower of drug plants can not give too much attention to the problem of finding a satisfactory market for his products. Growers who live near the cities in which dealers in crude drugs are located or in sections where wild medicinal plants are collected may be able to find a local market, but in many situations the local marketing of crude drugs in quantity will not be possible. In such cases the grower should send samples of his product to dealers in crude drugs or to manufacturers of pharmaceutical preparations and request them to name a price at which they would purchase his crop. The material for the samples should not be specially selected or so prepared as to represent a quality higher than that of the whole lot, since this would give the purchaser just cause for making a reduction in price on delivery or for rejecting the whole shipment. It is well to send samples to a number of dealers, since their prices will be found to vary with the stock on hand and trade prospects. Before selling, the state of the wholesale drug market should be learned. The prices to producers are, of course, always lower than the wholesale price; nevertheless, the grower who is informed in respect to the wholesale market will be in a position to judge of the fairness of the prices offered for his crop by dealers.

FIG. 4.—A still used in the production of wormwood oil

Under special conditions some crude drugs can be sold at a material advance over the prevailing market price. By always supplying a well-prepared, carefully selected drug of high quality some growers have built up a trade in their particular product for which they obtain extra good prices. Dealers and manufacturers also sometimes make contracts with reliable growers to take the entire crop of a particular drug, thus insuring to the grower a definite market and good prices for the product.

COMMERCIAL PROSPECTS

However desirable it may be to increase the available supply of crude drugs or to diminish the amount of money now sent to foreign

countries for these products, the most important consideration for the American farmer who would grow drug plants is the probable profit to be derived from such an enterprise. Many statements to the contrary notwithstanding, the commercial production of crude drugs does not normally present unusual opportunities for quick returns and large profits. Knowledge respecting the cultivation and handling of medicinal-plant crops is far less widespread than in the case of such generally distributed crops as fruits, vegetables, and cereals, and certain individuals have taken advantage of this lack of information to lead the public to believe that extraordinary profits may be realized from growing medicinal plants, even in a situation no more promising than the average city back yard. Such persons are interested usually only in the sale of the plants and seeds for propagation or the questionable directions for their cultivation, and the extravagant claims often set forth in their alluring advertisements are not only misleading, but frequently have little basis in fact.

The market demand for any given crude drug is naturally a large factor in determining the prospects for its commercial production under cultivation. The demand for a number of drugs is quite variable or exceedingly limited, and hence insufficient to make it advisable to raise them on a large scale. In the case of other drugs, although the demand is fairly constant and steady, it could probably be fully satisfied by the product of a very few acres of good land. It is evident that the cultivation of any considerable acreage might easily result in overproduction, with a consequent decline in market price to a point where production would not be profitable.

The cultivation of drug plants, to be successful in this country, will probably require the introduction of improved methods and the extensive use of machinery to replace hand labor so far as possible. Growers of mints and numerous other plants yielding essential oils will find it desirable to equip themselves with a suitable distilling plant, although the latter can not be operated most economically when only a small quantity of material is available for distillation. The natural tendency will be to increase the acreage in the interest of more efficient operation, but here again there is danger of overproduction, and prospective growers should thoroughly acquaint themselves with market conditions before bringing very large areas under cultivation.

Very few, if any, drug plants are used in quantities sufficient to make them a promising crop for general cultivation. Many of the common ones, which can be grown and prepared for market with little difficulty, bring but a few cents a pound, and their cultivation offers little prospect of profit. A number of the high-priced drug plants must be given care for two or more years before a crop can be harvested, and, since expensive equipment is usually required for their successful culture, the production of such crops offers little encouragement to inexperienced growers who are looking for quick returns and large profits from a small investment. The production of drugs of high quality requires skilled management, experience in special methods of plant culture, acquaintance with trade requirements, and a knowledge of the influence of time of collection and manner of preparation on the constituents of the drug which de-

termine its value. Small quantities of drugs produced without regard to these conditions are likely to be poor in quality and so unattractive to dealers and manufacturers that the product will not be salable at a price sufficient to make their production profitable. In general, the conditions in this country seem far more favorable to the growing of drug plants as a special industry for well-equipped cultivators than as a side crop for general farmers or those whose chief interest lies in the production of other crops.

Although a number of plants which yield products used as crude drugs are common farm weeds, they usually occur in scattered situations and in such small quantities that their collection would scarcely prove profitable for the farmer. Even when relatively abundant it is a matter for careful consideration whether the time and labor necessary for their collection might not be otherwise employed to better advantage. Moreover, it is not always easy to distinguish medicinal plants from others of similar appearance, and collectors not infrequently find that they have spent their time in gathering plants practically worthless as crude drugs. In proportion to the labor required in their collection, relatively low prices are paid for most crude drugs obtained from wild plants, and the farmer who turns to drug collecting as a source of additional revenue will probably meet with disappointment.

THE CULTIVATION AND HANDLING OF DRUG PLANTS

The following cultural directions and suggestions regarding the handling of a number of drug plants have been compiled in part from the records of the Division of Drug and Related Plants and include data procured by various members of the staff of that office connected with testing gardens in several widely separated localities. The probable yields per acre are in many cases estimates calculated from smaller areas, and considerable variation from the figures given must be expected in actual practice. The prices mentioned are given merely to indicate the comparative value of the products concerned and not to fix the actual price which the grower of drug plants may expect to receive. This will depend very largely upon the state of the market at the time the crop is offered for sale.

The plants mentioned in the following pages were selected for discussion because information regarding their cultivation is in constant demand. The purpose of this bulletin is not to recommend these plants for cultivation, but to give information concerning their culture which may be helpful to persons who are considering the production of drug plants on a commercial scale.

ACONITE

Aconite (*Aconitum napellus*) is a hardy perennial, introduced from Europe and sparingly grown in this country as an ornamental garden plant. Both leaves and roots are very poisonous, the latter forming the official drug. Other varieties than *Aconitum napellus* are also grown in flower gardens, and several species occur wild in the United States. Since the official species readily hybridizes with related varieties, often to the detriment of its medicinal properties, it is frequently difficult to procure seed which will come true to name.

Aconite seems to thrive best in a rather cool climate and will grow in any rich garden soil, but a well-drained gravelly loam in an elevated situation appears most suited for the cultivation of this plant. It may be grown from seed

sown in the open late in the fall or early in the spring, or plants may be started in a seed bed and the seedlings later transplanted and set about a foot apart in rows 2 feet apart. The preferable method of propagation is by division of the roots after the stems have died down in the fall, since thereby hybridization may be avoided.

The plants usually flower in the second year from seed, when the roots may be harvested. It is preferable, however, to defer harvesting until the stems have died down in the fall, when all the roots should be dug, the smaller reserved for planting and the larger ones washed, sliced lengthwise, and dried. The leaves are also harvested, but are not in much demand.

Reliable data on yield are not available, although some estimates place the yield at about 450 pounds of dry root per acre. The American market is supplied with imported aconite root, for which the price in July, 1935, ranged from 16 to 17 cents a pound. The quantity imported in 1934 was about 12,000 pounds. The demand for this drug is limited, and this fact together with the probable low yield, makes its profitable cultivation in this country very doubtful.

ALETRIS

Aletris, star-grass, or true unicorn root (*Aletris farinosa*, fig. 5), is a native perennial herb of the lily family, found occasionally on sandy soil throughout the eastern half of the United States; also frequently occurring in the pine and oak barrens of Alabama and Tennessee and elsewhere in the South. The root is used medicinally.

Aletris is a slow-growing plant which seems to thrive best on a moist and sandy soil. It may be propagated either by division of the rootstocks or from seeds. The seeds mature late in the summer, and should be sown soon after ripening, in a well-prepared and protected seed bed. In the following spring the seedlings may be transplanted to their permanent situation and set about a foot apart in rows 20 inches or more apart. The soil about the plants should be stirred frequently and kept free from weeds.

FIG. 5.—Aletris (*Aletris farinosa*)

The root, consisting of a short horizontal rootstock bearing numerous small rootlets, may be harvested in the fall of the second or third year. In preparing the root for market the stem and leaves are broken off and the dirt is removed by shaking (or washing, if necessary), after which it is well dried. There are no available data on the probable yield. The prices in July, 1935, were from 30 to 31 cents a pound.

ALTHAEA

Althaea or marshmallow (*Althaea officinalis*) is a perennial herb introduced from Europe which now grows wild in marshy places near the sea in Massachusetts and along tidal rivers in New York and Pennsylvania. The root forms the official drug, but the leaves and flowers also are sometimes used medicinally.

Althaea will grow well in almost any loose garden soil of moderate fertility, but tends to winterkill in situations where the ground freezes to a considerable depth. The plants may be propagated from seeds or from divisions of the old roots made early in the spring. The seed may be sown in the open in shallow drills at least 3 feet apart, and the seedlings should be thinned to stand 16 inches apart in the row. Under good conditions the plants attain a height of 3 or 4 feet; therefore close planting does not give sufficient room for full development.

In the second year of growth the roots are harvested, washed, peeled, cut into short lengths, and thoroughly dried. Yields at the rate of 800 to 1,000 pounds

of dry root per acre have been obtained. The price in July, 1935, was 22 to 28 cents a pound. The annual importations of this root have ranged from 6,000 to 28,000 pounds in recent years. In view of the amount of hand labor required in preparing the root, the relatively low price, and the rather limited demand, the cultivation of this plant for profit is not very attractive.

ANGELICA

Angelica (*Angelica officinalis*) is a European biennial plant of the parsley family, sometimes grown in this country as a culinary herb and known commonly as garden angelica. The fresh stems and leafstalks are used as a garnish and for making a candied confection. The seeds and the oil distilled from them are employed in flavoring, and the aromatic roots are sometimes used in medicine.

Angelica thrives best in a moderately cool climate and may be grown in any good soil, although a deep, fairly rich loam which is moist but well drained will give the best results. The soil should be deeply plowed and well prepared before planting. The plant is most readily propagated from divisions of old roots, which may be set either in the fall or in the spring about 18 inches apart in rows. The seeds germinate very poorly if more than 1 year old, and it is best to sow them as soon as they are ripe in a seed bed, which should be kept moist by frequent watering if necessary. Early in the following spring the seedlings are transplanted and set about 2 feet apart each way in their permanent location. Plants may also be obtained from seeds sown in March in a spent hotbed or in a coldframe. In order to increase the root development, the plants are often transplanted a second time, at the end of the first year's growth, and set 3 or 4 feet apart. For the same reason the tops are often cut back to prevent the formation of seed. During the growing seasons the soil should be kept mellow and free from weeds by frequent cultivation.

The roots are usually harvested in the fall of the second year, but sometimes those of the first-year plants are marketed. After being dug, the roots are washed and dried in the open air. In order to keep out insects and to preserve the aroma it is best to store the dried root in tin containers which can be tightly closed. The root of the European or garden angelica found in our drug markets is imported largely from Germany. During the last few years the wholesale price has averaged from 65 to 70 cents a pound.

The root of a native species of angelica (*A. atropurpurea*), commonly called American angelica, also occurs in the drug markets of this country. It is collected from wild plants, and the price to collectors in former years usually ranged from 6 to 10 cents a pound. The prices for the root in July, 1935, were 25 to 26 cents a pound.

ANISE

Anise (*Pimpinella anisum*) is an annual herb of the parsley family, widely cultivated in Europe and to a limited extent in this country, chiefly in Rhode Island. Although this plant may be grown quite generally throughout the United States, it has been found difficult to bring the crop to maturity in northerly situations where the growing season is short or in the South where the climate is hot and dry. It is grown chiefly for its aromatic seeds (fruits), which are used medicinally and also in baking and for flavoring confectionery. The oil distilled from the seeds is used medicinally in cordials and also for flavoring various beverages.

Anise thrives best in a light, moderately rich, and well-drained loam which has been carefully prepared for planting. It is grown from seed, which is usually sown early in the spring directly in the field, since the seedlings are unfavorably affected by transplanting. The seeds, which should not be more than 2 years old, are sown thickly, about two to the inch, and covered one-half inch deep. Since the plants develop very slowly, seed should not be sown in weedy soil. When the seedlings are 2 to 3 inches high they are thinned to stand 6 inches apart in the row. The rows may be 18 inches or 3 feet apart, depending on the cultivation intended. An ounce of seed should sow a row 150 feet long, and about 5 pounds will plant an acre when the rows are 3 feet apart. The plants should receive frequent and thorough cultivation throughout the growing season.

About three months from the time of planting the plants will blossom, and a month later the seed should be matured sufficiently for harvesting. As soon

as the tips of the seeds turn a grayish green color they should be harvested, for if allowed to remain exposed to the weather they quickly turn brown or blacken. The plants may be pulled by hand and stacked, tops inward, in heaps about 6 feet high, or they may be mowed and at once built up into cocks of the same height. In about four or five days the seed will have ripened, after which it should be threshed out and thoroughly cleaned.

Yields of anise seed are quite variable, since the plant is very sensitive to unfavorable weather conditions. In a good season from 400 to 600 pounds per acre may be reasonably expected. The prices in July, 1935, ranged from 9 to 12 cents a pound.

ARNICA

Arnica (*Arnica montana*) is a herbaceous perennial plant of the aster family, native in northern and central Europe, where it thrives in the cool climate of the mountain meadows and upland moors. The flowers, leaves, and roots are employed in medicine.

Arnica requires a marshy soil, abundant rainfall, and a cool climate for its best development. It is propagated by divisions of the roots or from seeds sown in either the fall or the spring. Seed may also be sown in August in a seed bed and the plants transplanted the following spring to stand about 18 inches apart in the row. The flowers may be harvested the second year and the roots after three or four years.

Arnica is not produced commercially in the United States, and the small quantity imported annually is apparently sufficient to meet the market demands. Its cultivation presents many difficulties, and efforts to grow it in the milder portions of this country have generally proved unsuccessful. In July, 1935, the flowers were reported at 15 to 16 cents a pound and the root at 38 to 40 cents.

BELLADONNA

Belladonna or deadly nightshade (*Atropa belladonna*) is a large, poisonous perennial which occurs wild in Europe, where it is also cultivated. Both the leaves and the roots are important crude drugs. In recent years it has been cultivated to some extent in this country, but it is likely to winterkill in the colder sections.

Belladonna may be propagated in a small way from cuttings of the young shoots rooted in moist sand in the usual manner or from divisions of the fleshy rootstocks made early in the spring, but it is most readily grown from seeds which may be thinly sown in pots or well-drained boxes in a cool greenhouse in midwinter or in a sheltered place in a garden early in the spring. When the seedlings are large enough to handle they should be transplanted singly to small pots or pricked out in flats or shallow boxes of light, rich soil, placing them about 2 inches apart each way, as with tomato or other vegetable plants intended for field planting. In the spring, as soon as danger from frost is over, they should be transplanted to the field and set about 20 inches apart in rows 30 or more inches apart. Sowing seeds in the field or transplanting directly from the seed bed to the field has rarely given good results in this country. Belladonna seeds are small, and if well handled under glass or in protected seed beds 1 ounce should produce 10,000 or more plants, sufficient to set an acre.

Belladonna thrives best in deep, moist, well-drained loam containing lime, such as will under proper fertilization produce good garden vegetables. The preparation of the soil should be very thorough, and consists of deep plowing, in either fall or early spring, and repeated working with the disk or springtooth and smoothing harrows. Weeds should be kept under control at all times and the soil stirred with a hoe or cultivator at intervals of about 10 days, particularly after each hard rain, and shallow cultivation given in hot, dry weather to conserve the natural moisture of the soil. Good commercial fertilizers, such as are commonly used in truck gardens, are beneficial. Those containing 8 per cent of phosphoric acid, 4 per cent of nitrogen, and 4 per cent of potash are the most desirable, and should be applied at the rate of about 600 pounds per acre. Stable manure at the rate of 12 to 20 tons to the acre may be used if plowed under when the ground is prepared.

Belladonna is sometimes affected by a wilt disease, which is aggravated by wet soils and fresh animal manures, and the foliage is greedily attacked by the potato beetle. Dusting with lime, soot, or road dust in the morning when the leaves are wet with dew is occasionally effective. The destructive attacks of these pests are usually confined to the seed bed or to first-year plantings, but the insects may be controlled by the careful use of insecticides.

The leaves are picked when the plants are in full bloom. They should be carefully handled, to avoid bruising, and dried in the shade in order to retain their green color. A hundred pounds of fresh leaves yield about 18 pounds when well dried. One crop only can be collected the year of planting, but two crops are gathered in each of the next two or three years, after which it appears better to market the roots and make new plantings. While only the leaves should be collected for the best pharmaceutical trade, the young growth, including the smaller sappy twigs, has medicinal value and may be sheared from the plants and dried in the same manner as the leaves. The ease of collection and the increased weight of material may render the latter method more profitable.

The roots alone are not as profitable as the leaves. The best roots are those of the second and third year's growth. They are harvested in the fall after frost, the tops being mowed and raked off and the roots turned out with a deep-running plow, or with a potato fork if the area be small. They are carefully washed and cut into about 4-inch lengths, the larger pieces being split lengthwise to aid in drying. Thorough drying either in the sun or with mild artificial heat is essential; otherwise the roots will mold when stored.

The high prices paid for belladonna during the war greatly stimulated the cultivation of this crop, which had previously been grown with some success in California, Michigan, Indiana, Pennsylvania, New Jersey, and some other States. In 1918, 273 acres of belladonna were harvested, the total production being about 83 tons of herb (including leaves and stems), an average of 600 pounds per acre. From 136 acres 11 tons of root were harvested, an average of 164 pounds per acre. Quotations in July, 1935, were 14 to 15 cents a pound for the leaves and 13 to 14 cents a pound for the root.

BLUE FLAG

Blue flag (*Iris versicolor*) is a native perennial plant of common occurrence in swamps and marshy situations throughout the eastern half of the United States. The underground stem (rhizome) and roots are the parts of the plant used medicinally.

Blue flag responds readily to cultivation when placed in a rich, moist, and rather heavy soil. It is readily propagated from divisions of old plants, which may be set 1 foot apart in rows spaced conveniently for cultivation. If the plants are set in August or September, the crop may be harvested about the last of October in the following year. The roots may be turned out with a deep-running plow, and after being thoroughly washed and the larger clusters broken up they should be thoroughly dried. Artificial drying at low heat is usually desirable.

Yields at the rate of 3 or 4 tons of dried root per acre have been obtained from small plots. The price in July, 1935, was 12 to 14 cents a pound. This crop does not appear to be very promising, owing to the relatively small demand for the root.

BONESET

Boneset (*Eupatorium perfoliatum*) is a hardy, rather long-lived perennial plant commonly found growing in low grounds throughout the eastern half of the United States. The dried leaves and flowering tops form the official drug.

Divisions of clumps of wild plants collected early in the fall will serve for propagation. These may be set about a foot apart in rows in well-prepared soil. During the first winter the newly set divisions should be protected with a light mulch of straw or manure. Plants may also be grown from seeds, which should be collected as soon as ripe and sown in shallow drills about 8 inches apart in a rich, moist seed bed, preferably in partial shade. When of sufficient size they may be set in the field at about the same distance as the divided clumps.

The plants are cut late in the summer when in full bloom and the leaves and flowering tops stripped from the stem by hand and carefully dried without exposure to the sun. Yields of well-cultivated boneset are quite large and 2,000 pounds or more per acre of dry herb may be obtained under favorable conditions. The price in January, 1934, was 9 to 10 cents a pound. Since the demand is limited and the wild supply fairly available, the cultivation of boneset does not offer much prospect of profit.

BURDOCK

Burdock (*Arctium lappa*) is a large biennial plant well known as a common and troublesome weed in the Eastern and Central States and in some western localities. The dried root from the plants of the first year's growth forms the official drug, but the seeds and leaves are also used medicinally.

Burdock will grow in almost any soil, but the best root development is favored by a light well-drained soil rich in humus. The seeds germinate readily and may be sown directly in the field, either late in the fall or early in the spring. The seed may be sown in drills 18 inches or 3 feet apart, as desired, and should be sown 1 inch deep if in the fall, but less deeply if sown in the spring. When the seedlings are well up they should be thinned to stand about 6 inches apart in the row. Cultivation should continue as long as the size of the plants will permit.

The roots are harvested at the end of the first year's growth in order to obtain the most acceptable drug and also to prevent the plants from bearing seed and spreading as a weed. The tops of the plants may be cut with a mower and raked off, after which the roots can usually be turned out with a deep-running plow or with a beet lifter. In a dry and very sandy soil the roots frequently extend to a depth of 2 or 3 feet, making it necessary to dig them by hand. After digging, any remaining tops are removed and the roots are washed and dried, the drying being preferably by the use of low artificial heat. The roots are usually split lengthwise into two or more pieces in order to facilitate drying, although whole roots are marketable.

Yields at the rate of 1,500 to 2,000 pounds of dry roots per acre have been obtained. In 1934 almost 7,000 pounds were imported. The price for the root in July, 1935, was 11 to 12 cents a pound.

CALAMUS

Calamus or sweet flag (*Acorus calamus*) is a native perennial plant, occurring frequently along streams and in the edges of swamps throughout the eastern half of the United States. The dried root (rhizome or rootstock) is the part used as a drug.

Although calamus in a wild state is usually found growing in water, it may by cultivated in almost any good soil which is fairly moist. It usually does well on moderately dry upland soils which will produce fair crops of corn or potatoes. The plants are readily propagated from divisions of old roots, which should be set early in the fall 1 foot apart in rows and well covered. During the following growing season the plants should receive frequent and thorough cultivation.

The roots are harvested in the fall and may be readily dug with a spade or turned out with a plow. The tops, together with about an inch of the rootstock, are next cut off and used to make new plantings. The roots are washed and dried artificially at a moderately low degree of heat. The marketable product consists of the thick rootstocks deprived of their small rootlets, often called "fibers." These may be removed before drying, but more easily afterwards, since when dry and brittle they break off readily with a little handling. Roots thus treated are often called "stripped" and are more aromatic than those which have been peeled.

Yields at the rate of 2,000 pounds of dry roots per acre have been obtained. The price of the root is not regularly quoted but is usually less than 10 cents a pound. The annual importation of calamus root ranges from 5 to 10 tons.

CALENDULA

Calendula or pot marigold (*Calendula officinalis*) is a hardy annual plant native to southern Europe, but frequently grown in flower gardens in the United States. The dried flower heads are sometimes used in soups and stews, and the so-called petals (ligulate florets) are employed in medicine.

Calendula grows well on a variety of soils, but a moderately rich garden loam will give the best results. The seed may be sown in open ground early in the spring in drills 18 inches apart. As soon as the seedlings are well established they should be thinned to stand about a foot apart in the row. In the North it is desirable to sow the seed about the first of April in coldframes or spent hotbeds and transplant the young seedlings as soon as the danger of frost is past.

The plants blossom early and continue to bloom throughout the summer. The flowers are gathered at intervals of a few days and carefully dried. The petals (florets) which form the drug may be removed either before or after the flower heads are dried. The petals are removed by hand, but this process requires so much time that when the cost of the necessary labor is taken into account it is doubtful if the price received for the drug would cover the cost of production.

The dried petals produced in this country were quoted in the wholesale markets in July, 1935, at 75 to 80 cents a pound, according to quality.

CAMOMILE, GERMAN

German camomile (*Matricaria chamomilla*) is a European annual herb of the aster family, cultivated in this country in gardens, from which it has escaped in some localities. The dried flower heads are used in medicine.

This species of camomile does well on moderately heavy soil which is rich in humus and rather moist. Since the plants bloom about eight weeks after sowing the seed, a crop of camomile may be grown from seed sown either early in the spring or late in the summer, following early vegetable crops. The seed may be sown in drills and barely covered or may be broadcast, since the plants will soon occupy the ground and exclude the weeds. When the plants are in full bloom the flower heads are gathered and may be spread thinly on canvas sheets and dried in the sun. All leaves and stems should be removed, and when the flowers are thoroughly dry they should be packed for market in boxes or bales rather than in bags, since in the latter the flowers are likely to be badly broken in handling.

Returns from experimental areas indicate that a yield of about 400 pounds of dry flowers per acre may be expected under favorable conditions. The wholesale price in July, 1935, was 20 to 22 cents a pound.

CAMOMILE, ROMAN

Roman camomile, also called English camomile (*Anthemis nobilis*), is a European perennial herb of the aster family, frequently cultivated in gardens in this country and sometimes found growing wild. In America camomile is grown chiefly as an ornamental plant, especially for use in borders, since the plants blossom from midsummer until killed by frost. The dried flowers heads from cultivated plants are used in medicine.

Camomile grows well in almost any good, rather dry soil which has full exposure to the sun. The plants may be grown from seeds or propagated by dividing the roots early in the spring. The divisions of the root may be planted 9 inches apart in rows spaced according to the method of cultivation to be used. When planted on a small scale the divisions, or offsets, may be set 9 inches apart each way in carefully prepared soil. Hand weeding is necessary, but since the plants soon spread and fully shade the ground, weeds usually have small chance of becoming troublesome.

The flower heads are gathered just as they open, either by hand or by means of a flower picker, and are dried in the open in bright weather or, when necessary, on canvas trays in a heated room. Rapid drying is essential, as it is desirable to retain the white color as far as possible.

The yield is variable, but from 400 to 600 pounds of dried flowers per acre may be expected. The prices for Roman camomile quoted in the wholesale drug markets of this country in July, 1935, were 58 to 60 cents a pound. Since this crop requires much hand labor, its cultivation in this country on a commercial scale does not promise to be very profitable.

CARAWAY

Caraway (*Carum carvi*) is a European biennial herb of the parsley family. It grows and fruits well over a considerable portion of the United States, especially in the North and Northwest, but its cultivation in this country seems never to have assumed commercial proportions. The seeds are used medicinally, but are mainly utilized for flavoring bread, cakes, cheese, confectionery, and similar products. On distillation with steam the seeds yield an aromatic oil, which is more used in medicine than the seed itself.

Soil of a somewhat clayey nature and containing a fair proportion of humus and available plant food is particularly suited to caraway, but the plant generally grows well in any good upland soil which will produce fair crops of corn or potatoes. Seeds should be sown in early spring in drills about 16

inches apart, and from 6 to 8 pounds of seed are sown to the acre. Frequent shallow cultivation throughout both growing seasons is desirable in order to keep the soil mellow and free from weeds, as a weedy crop at harvest time usually means a product inferior in quality.

As soon as the oldest seeds ripen, which is usually in June of the second year, the crop should be harvested. The plants may be cut with a mower and should be left in the swath until they have lost most of their moisture, when they may be built up into small cocks, or they may be brought in from the field and the curing finished in a barn loft. If on handling in the field the seeds shatter extensively, the crop should be brought in in tight wagons. When drying is finished the seeds are threshed out, cleaned, and stored in bags which contain about 100 pounds each.

Returns from experimental areas indicate that a yield of about 1,000 pounds of seed per acre may be expected. One hundred pounds of seed will usually yield 4 to 6 pounds of oil. The average annual importation of caraway seed for the last five years has been about 4,500,000 pounds and the annual importation of caraway oil over the same period has ranged from 5,000 to 9,000 pounds. In July, 1935, the seed was quoted at 7½ to 7¾ cents a pound and the oil at $1.95 to $2.20 a pound.

CASCARA SAGRADA

Cascara or cascara sagrada (*Rhamnus purshiana*) is a small tree 20 to 30 feet high, native to the western part of the United States, and found most abundantly in a narrow belt along the Pacific slope from northern California to southern British Columbia. The bark from the trunk and branches is the source of the drug, for which there is a constant and steady demand.

Plantings which have been made in the Eastern States indicate that this tree may probably be grown along the Atlantic slope in the Piedmont or foothill belt from Pennsylvania to Georgia. The trees have been found to grow better in clay loam than in either sand or clay. Propagation from seed is easy, but the seeds should be planted in the fall soon after they ripen or stratified in sand until used, since germination is very poor if the seeds are allowed to become dry. The seeds are sown in a seed bed under shade in drills 8 inches apart and covered about 1 inch deep. The seedlings reach a height of 10 to 15 inches the first year, and in the following spring before the leaves appear they are set in the field 6 feet apart each way. It is advisable to cultivate frequently in order to keep the weeds down and to maintain a shallow surface mulch.

If the trees are pruned properly, a crop of bark may be harvested each year without killing the whole tree, as is done in collecting the bark from wild trees. At the time of transplanting, the trees are cut back to a straight stem about a foot high, from which all except the four uppermost buds are removed. The branches which afterwards develop from these buds are later deprived of their lower side shoots, thus causing the tree to grow a head of four long, stout branches instead of a single straight trunk. When the trees are large enough to yield a crop of bark, the longest of the four branches is cut off early in the spring, flush with the trunk, and a new branch is allowed to grow in its place. This process may be repeated yearly, removing only the largest branches of each tree in any one season.

The bark on the cut-off branches is divided with a sharp knife into lengthwise strips of about an inch or two in width, which may be readily pulled off. It is then dried carefully at a low temperature in the shade and broken into small pieces to facilitate packing and handling.

The wholesale price of cascara bark in July, 1935, was quoted at 8 to 10 cents a pound, according to the age of the bark. Aging is said to improve the quality of the bark and to make it more valuable.

So long as a supply of the wild bark continues to be available it is doubtful if cascara can be cultivated at a profit.

CASTOR BEANS

The castor-oil plant or palma Christi (*Ricinus communis*) is a robust perennial in tropical countries which becomes an annual in regions subject to frost. The seeds of this plant, called "castor beans" or "mole beans," yield the castor oil of commerce. Between 1860 and 1900 the castor bean was an important crop in certain sections of Oklahoma, Kansas, Missouri, and

Illinois, but during recent years its culture has been practically abandoned in favor of crops which are easier to handle and more profitable.

For the commercial production of castor beans a warm climate and a long growing season are necessary. If planted much farther north than St. Louis, Mo., or Washington, D. C., the crop is very likely to be caught by frost. In general, any fertile soil which produces goods crops of cotton or corn is suitable for castor beans, but a very fertile soil favors the growth of the plant at the expense of seed production and early maturity. The land is prepared in much the same manner as for cotton or corn; that is, plowed, disked, and harrowed level before planting, which may be done by hand or with a corn planter with specially prepared plates. The seed should be planted early in the spring, as soon as the soil is warm but still moderately moist. The time of planting varies according to locality, but in general corresponds to that of cotton.

The seed is planted in hills at a depth of 1 to 2 inches. Toward the north the rows are usually made 4 feet apart and the hills spaced 3 feet apart in the row. Farther south the rows should usually be made about 6 to 8 feet apart. On very light land the hills may be 4 feet apart in the row; on heavier land, 6 to 8 feet apart. As a general rule three seeds are planted to the hill, and not less than two should be planted. One bushel of medium-sized seed should plant from 5 to 6 acres. When the plants are from 4 to 6 inches tall, the weaker ones should be removed, leaving one plant in a hill.

The crop is cultivated like corn until the plants are large enough to shade the ground. In case the field becomes foul with weeds and grass some hoeing may be necessary, but practically all the cultivation required can be done with a horse-drawn weeder. Some varieties in which the beans pop out when the hull is fully ripe are known locally as "poppers," and after the beans begin to ripen, the field must be gone over every few days and the ripe beans collected in order to avoid loss. Other varieties tend to retain the beans in the hull after they are ripe. The climate affects the popping of the beans, and a variety which shatters badly in one region may shatter very little when grown in another.

In harvesting, a common method is to cut off the spikes with a knife and collect them in large sacks. They are then hauled to a shelter of some kind and allowed to dry until the pods will crush easily. Various methods are used in threshing castor beans. If the variety grown is one which "pops" or drops its seeds when they are ripe, the spikes are sometimes piled on a hard ground or plank floor fully exposed to the sun and furnished with sides of boards or cloth 6 to 8 feet high to catch the beans as they pop out. In some varieties mere drying does not cause the pods to open, and specially constructed machines have been used to remove the beans from the pods. After the beans have been threshed or popped out, a fanning mill is used to separate the hulls, chaff, and dirt from the beans, which are then sacked and stored for market.

The yield varies greatly and will depend much upon cultural conditions, the season, the variety grown, and the care exercised in harvesting and threshing the seeds. In Oklahoma the average yield of the popping varieties is said to be 8 to 10 bushels per acre. Yields up to 25 bushels per acre have been reported for favorable conditions.

For some years prior to the war the farm price for castor beans was about $1 a bushel. Early in the war the increased demand for castor oil caused a sharp advance in the price of the beans, which has gradually declined since. The normal requirement in the United States for castor beans is from 1,500,000 to 2,000,000 bushels annually. In 1934 more than 2,000,000 bushels were imported. Their value is usually between $1 and $2 a bushel.

In the United States castor beans are used in quantity only by manufacturers of castor oil. In general, the equipment and operation of a castor-oil mill resembles that of a cottonseed-oil mill or a linseed-oil mill, but special and expensive equipment is necessary for the proper extraction of the oil from castor beans. The best grade of oil is obtained from the beans by hydraulic pressure. An additional quantity of oil of lower grade is obtained by treating the press cake with naphtha or some other volatile solvent. The pomace resulting from the second extraction is used as a fertilizer for tobacco, corn, and other crops, but because of a poisonous principle can not be used for cattle feeding unless specially treated.

Owing to the heavy outlay required for the necessary machinery and the high cost of manufacture on a small scale, it has not been found profitable for the growers of castor beans to undertake the extraction of the oil.

The castor-oil plant is not known to be poisonous, and although the leaves are not relished by farm animals they are said to be used as fodder for cattle in India. Castor beans, however, contain a poisonous principle, and though harmless when handled, may cause serious if not fatal effects when eaten, especially in the case of small children. Care should be taken to prevent these beans from being accidentally mixed with the grain fed to animals, since many cases have been reported in which the death of horses has been due to eating feed in which they have become mixed.

CATNIP

Catnip (*Nepeta cataria*) is a European perennial plant of the mint family, which frequently occurs in this country as a weed in gardens and about dwellings. It has long had a popular use as a domestic remedy. Both leaves and flowering tops find some demand in the crude-drug trade.

Catnip does well on almost any good soil, but thrives best on a well-drained and moderately rich garden loam. However, a more fragrant and attractive herb can be grown in sandy situations than in heavy soils. The plant may be propagated from seeds or by root division. The seed may be sown in rows either late in the fall or in early spring and covered lightly. Fall-sown seed usually gives a more even stand and a heavier growth of herb. When the plants have reached a height of 4 to 5 inches they should be thinned to stand from 12 to 16 inches apart in the rows. In some localities the field sowing of seed does not give good results, in which case plants may be started in a coldframe and later transplanted to the field. Shallow cultivation will favor a vigorous growth of the herb.

The flowering tops are harvested when the plants are in full bloom and are dried in the shade to preserve their green color. In case the herb is grown in large quantity, it may be cut with a mowing machine, the cutter bar of which should be set high. The plants should lie in the swath until partially dry, and the curing may then be finished either in small cocks in the field or in the barn, care being taken to preserve the natural green color as far as possible.

Returns from experimental areas indicate that a yield of about 2,000 pounds of dried flowering tops per acre may be expected under good conditions. The herb must be carefully sorted and all the large or coarse stems removed, after which it may be made up for the market in bales of 100 to 300 pounds each. The price in July, 1935, for the leaves was 19 to 20 cents a pound.

CHAMOMILE. (See CAMOMILE)

CONIUM

Conium or poison hemlock (*Conium maculatum*) is a large, poisonous European biennial plant of the parsley family, naturalized in the Northeastern States and in California. The full-grown but unripe seeds (fruits) and the leaves are used medicinally.

Conium is easily grown and has been found to thrive in both comparatively moist clay soil and in dry sandy loam. In rich, moist land it may easily become a troublesome weed. Conium grows readily from seed, which may be sown either in the fall or early in the spring in drills 2 or more feet apart. As soon as the seedlings can be distinguished in the row, cultivation similar to that given ordinary garden crops is begun. The plants usually blossom in the second year, and when the oldest seeds are full grown but still green in color the plants are harvested and the seed at once threshed out and dried with the least possible exposure to the light. The small and undeveloped seed should be screened out and rejected and the good seed stored in containers that will exclude light and air. The leaves are collected when the plant is in flower, quickly dried in the sun, and stored in the same manner as the seed.

Estimated yields at the rate of 600 to 800 pounds of seed per acre have been obtained, but the yield is very uncertain, since the flowering plants are especially subject to the attacks of insects which destroy the crop of seed. The price in July, 1935, for the leaves was 14 to 15 cents a pound. The price of the seed has not been quoted in recent years.

CORIANDER

Coriander (*Coriandrum sativum*) is an Old World annual of the parsley family. For years the plant has been cultivated in gardens of the United States, and it is now reported as growing wild in many places. The aromatic seeds and the oil distilled from them have long been used medicinally. Both the seed and the oil are also used for flavoring confectionery and cordials and as a condiment in bread and cake.

Coriander grows well on almost any good soil, but thrives best on deep and fertile garden loam. The soil should be well prepared before planting, which should be done moderately early in the spring. For field cultivation the seed is sown in rows 3 feet apart, but if the cultivation is done by hand the distance between the rows may be reduced to 18 inches. The seed should be sown thickly in order to insure a good stand. When well up, the plants are thinned to stand 4 or 5 inches apart in the row. Cultivation should continue until the plants flower, which will be about two months from the time of planting.

When most of the seeds are ripe the plants are cut with a scythe or a mower, preferably early in the morning while moist with dew, in order to avoid shattering the seed. The plants are partially cured in small cocks in the field, the drying being finished in a barn loft or under other suitable shelter, after which the seeds are threshed out and cleaned.

The yield of seed is quite variable, but returns from experimental areas indicate that from 500 to 800 pounds per acre may be expected. Five hundred pounds of seed will usually yield from 1 to 5 pounds of oil, according to the localities where grown. The importation of coriander seed in 1934 was about 1,800,000 pounds. In July, 1935, coriander seed was quoted at 2¾ to 4 cents a pound, and the oil at $3.25 to $3.50 a pound wholesale.

DANDELION

Dandelion (*Taraxacum officinale*) is a well-known and troublesome perennial weed, occurring abundantly almost everywhere in this country except in the Southern States. It is frequently cultivated in market gardens for the leaves, which are used for greens or salads, but the root alone is used in medicine.

This plant will grow well in any good soil and has been successfully cultivated in the South, but in the colder parts of the country it may require slight mulching during the winter if the roots tend to heave out of the soil. The seeds, which are sown in the spring, are drilled in rows 18 inches apart and covered one-half inch deep. About 3 pounds of seed should sow an acre. The seedlings are thinned to stand a foot apart in the row, and the crop should be well cultivated and kept free from weeds.

The roots are dug in the fall of the second season after planting the seed. They should be washed and may be dried whole, or, to facilitate handling and drying, they may be cut into pieces 3 to 6 inches long and the larger portions sliced. Under favorable conditions, yields at the rate of 1,000 to 1,500 pounds of dry roots per acre have been obtained from second-year plants. The price in July, 1935, was 18 to 19 cents a pound. The quantity annually imported into this country varies from year to year, and in the past has averaged about 65 tons. No recent figures are available.

A serious disadvantage attending the cultivation of this crop is the danger of seeding adjacent land with a very undesirable weed.

DIGITALIS

Digitalis or foxglove (*Digitalis purpurea*) is a fairly hardy European perennial, which has long been grown in flower gardens in this country as an ornamental plant. The leaves are used in medicine.

Digitalis thrives in ordinary well-drained garden soils of open texture and reasonable fertility. Sowing the seed directly in the field occasionally gives good results, but is so often unsuccessful that it can not be recommended. The seeds are exceedingly small and do not germinate well except under the most favorable conditions. They should be mixed with sand, to insure even distribution in seeding, and sown as early as February in seed pans or flats in the greenhouses or in well-protected frames. When danger of frost is past the plants should be hardened off and transplanted to the field, where they may be set about a foot apart in rows spaced conveniently for cultivation.

The plants do not flower until the second year, and it is necessary to cultivate them frequently during the growing seasons of both the first and the second

year. In localities where the cold weather is severe it may be desirable to protect the plants during the first winter with a light mulch of straw or coarse farmyard manure.

It was formerly supposed that the leaves were not medicinally active until the second year's growth, but it is now generally recognized that those of the first year's growth are equally as potent. Leaves, therefore, may be harvested the first year when the plants have reached sufficient size and annually thereafter. They are carefully dried in the shade and should be stored in such a manner that they will not be exposed to light and moisture. The results of experiments indicate that yields of 450 to 600 pounds of dry leaves per acre may be obtained under favorable conditions. In considering digitalis culture it should be borne in mind that the crop occupies the soil for the greater part of two seasons and demands even closer attention than many truck or garden crops.

In 1919 small areas of cultivated digitalis, ranging from one-half to 1 acre in extent, were harvested in Pennsylvania, South Carolina, Washington, California, and some other States. Several tons of digitalis leaves were also collected from plants of wild growth in the general region of the Coast Range of mountains on the Pacific coast. Digitalis is of great medicinal importance, and its extensive use is indicated by the fact that although administered in very small quantities on account of its potency more than 50,000 pounds are usually imported annually. The price for digitalis leaves in July, 1935, was from 25 to 26 cents a pound.

DILL

Dill (*Anethum graveolens*) is an Old World annual or biennial herb of the parsley family. Although it is a native of southern Europe, it is a hardy plant and may be grown in a much cooler climate if given a warm situation and a well-drained soil. The leaves are used for seasoning, and the seeds (fruits), which are greatly valued for flavoring pickles, are used as a condiment and occasionally in medicine. A volatile oil distilled from the seeds is used chiefly for perfuming soap.

Dill is preferably grown as an annual plant, in which case the seed should be sown about one-half inch deep very early in the spring in drills a foot apart. A half ounce of seed is sufficient to sow 150 feet of drill, and at this rate a pound should sow an acre. When sown in the field the rows may be 15 to 18 inches apart, and the seedlings should be thinned to stand about a foot apart in the row. The most favorable soil is a well-prepared loam, but the plants grow well in any good garden soil. Frequent cultivation and freedom from weeds are essential for good results.

Early in the fall, as soon as some of the older seeds are ripe, the plants are mowed and built up into small cocks in the field, or, if sufficiently dry, the seeds may be threshed out at once. In very dry weather it is preferable to mow the plants early in the morning while they are moist with dew, in order to avoid shattering the seed. In case the seed is very ripe, it is well to cut the plants high and to place the tops directly on large canvas sheets, in which they may be brought from the field. After threshing, the seeds should be spread out in a thin layer and turned frequently until thoroughly dry, since they tend to become musty if closely stored before all the moisture has been removed.

The yield of dill seed is quite variable and is much influenced by climatic conditions. From 500 to 700 pounds of seed per acre is considered a good yield. The wholesale price in July, 1935, ranged from 6¾ to 7½ cents a pound.

ECHINACEA

Echinacea (*Echinacea angustifolia*, fig. 6) is a native perennial plant of the aster family found on the prairies of the Middle West, occurring most abundantly in Nebraska and Kansas. The roots of the plant are used medicinally.

This plant has been found to do well under cultivation in moderately rich and well-drained loam. It grows fairly well from seeds, which may be collected when ripe and kept dry until ready for use. Plants should be started in a well-prepared seed bed by sowing the seeds thinly in drills about 8 inches apart. The plants develop slowly and may be left in the seed bed for two years and then transplanted to the field in the spring and set about 18 inches apart in rows. Thorough cultivation is essential for the best results. The

roots do not reach a marketable size under three or four years from the time of sowing the seed. They are harvested in the fall, freed from any adhering soil, and dried either in the open air or by means of low artificial heat.

Echinacea has not been cultivated on a scale large enough to give satisfactory data on the probable yield. The wholesale price in July, 1935, was 17 to 18 cents a pound.

ELECAMPANE

Elecampane (*Inula helenium*) is a European perennial plant of the aster family, now growing wild along roadsides and in fields throughout the northeastern part of the United States. The root is used in medicine.

Elecampane will grow in almost any soil, but thrives best in deep clay loam well supplied with moisture. The ground on which this plant is to be grown should be deeply plowed and thoroughly prepared before planting. It is preferable to use divisions of old roots for propagation, and these should be set in the fall about 18 inches apart in rows 3 feet apart. Plants may also be grown from seeds, which may be sown in the spring in seed beds and the seedlings transplanted later to the field and set in the same manner as the root divisions. Plants grown from seed do not flower the first year. Cultivation should be sufficient to keep the soil in good condition and free from weeds.

FIG. 6.—Echinacea (*Echinacea angustifolia*)

The roots are dug in the fall of the second year, thoroughly cleaned, sliced, and dried in the shade. The available data on yield indicate that a ton or more of dry root per acre may be expected. The wholesale price quotations in July, 1935, were 5 to 6 cents a pound. Upward of 50,000 pounds of elecampane root were annually imported into this country prior to the war.

FENNEL

Fennel (*Foeniculum vulgare*) is an Old World perennial plant of the parsley family, occasionally cultivated as a garden herb in the United States. The aromatic seeds (fruits) are used in medicine and for flavoring. The oil distilled from the seeds is used in medicine and to some extent for flavoring.

Fennel grows wild in mild climates in almost any good soil and thrives in rich, well-drained loams containing lime. It is propagated from seeds, which may be sown in the open as soon as the ground is ready for planting in the spring. The seed is sown thickly in drills 2 to 3 feet apart and covered lightly. From 4 to 5 pounds of seed should sow an acre. When well established the plants may be thinned to stand 12 to 15 inches apart in the row. Plants may also be started in a seed bed from seed sown either in drills 6 inches apart or broadcast. When the seedlings are 3 or 4 inches high they are transplanted to the field and set 12 to 15 inches apart in rows. The cultivation is the same as for ordinary garden crops.

Frequently very little seed is formed the first year, but full crops may be expected for one or two succeeding years. The seed is gathered in the fall before it is fully ripe and may be harvested like anise or coriander. A yield of 600 to 800 pounds of seed per acre may be expected. During the past five years from 150,000 to 350,000 pounds have been imported annually. The prices in July, 1935, for the seed were 9 to 18 cents a pound; for the oil, $1 to $1.25 a pound

GENTIAN

The common or yellow gentian (*Gentiana lutea*) is the only species recognized in American medicine, although the roots of several other species are found in

the drug trade. The plant grows wild in the mountains of central and southern Europe, but it has proved very poorly adapted for cultivation in situations beyond its natural range. For its best development under cultivation, partial shade, similar to that required by ginseng and goldenseal, seems necessary. The plants are said to flower when about 6 years old; hence, several years must elapse after sowing the seed before the roots reach a marketable size. Apparently there have been no attempts to cultivate gentian commercially in this country. The price in July, 1935, was 8½ to 9 cents a pound.

GINSENG

Ginseng (*Panax quinquefolium*) is a fleshy-rooted herbaceous plant native to this country and formerly of frequent occurrence in shady, well-drained situations in hardwood forests from Maine to Minnesota and southward to the mountains of Georgia and the Carolinas. It has long been valued by the Chinese for medicinal use, though rarely credited with curative properties by natives of other countries. When placed under cultural conditions, ginseng should be shielded from direct sunlight by the shade of trees or by lath sheds. The soil should be fairly light and well fertilized with woods earth, rotted leaves, or fine raw bone meal, the latter applied at the rate of 1 pound to each square yard. Seed should be planted in the spring as early as the soil can be worked to advantage, placed 6 inches apart each way in the permanent beds or 2 by 6 inches in seed beds, and the seedlings transplanted to stand 6 to 8 inches apart when 2 years old. Only cracked or partially germinated seed should be used.

Ginseng needs little cultivation, but the beds should at all times be kept free from weeds and grass and the surface of the soil slightly stirred whenever it shows signs of caking. A winter mulch over the crowns is usually essential, but it should not be applied until freezing weather is imminent and should be removed in the spring before the first shoots come through the soil.

The roots do not reach marketable size until about the fifth or sixth year from seed. When dug they should be carefully washed or shaken free from all adhering soil, but not scraped. Curing is best effected in a well-ventilated room heated to about 90° F. Nearly a month is required to cure properly the larger roots, and great care must be taken in order to prevent molding or souring. Overheating must also be avoided. When well cured the roots should be stored in a dry, airy place until ready for sale. A market may be found with the wholesale drug dealers, some of whom make a specialty of buying ginseng root for export. In the last 10 years the exports have averaged about 180,000 pounds annually, but the price has declined in recent years due to overproduction.

The price of cultivated ginseng roots, as quoted in wholesale drug lists, ranges from 40 cents to $4 a pound, according to quality and freedom from disease.

Further details respecting the culture of ginseng are given in Farmers' Bulletin 1184, "Ginseng Culture," and in Farmers' Bulletin 736, "Ginseng Diseases and Their Control."

GOLDENSEAL

Goldenseal (*Hydrastis canadensis*) is a native perennial, formerly quite abundant in open woodlands having ample shade, natural drainage, and an abundance of leaf mold. Its range is from southern New York and Ontario west to Minnesota and south to Georgia and Kentucky.

When grown under cultivation the soil should be well fertilized, preferably by decaying vegetable matter, such as woods soil and rotting forest leaves, which should be well worked in to a depth of 10 inches or more. Raw bone meal and cottonseed meal are also favorable in their action. Seed may be sown in October in a well-prepared seed bed. It may be scattered broadcast or dropped one-half inch apart and covered with fine leaf mold to the depth of 1 inch. During the winter the seed bed should be protected with burlap or fertilizer sacks, and should also be guarded against encroachment of moles or mice. Plants may be set 6 to 8 inches apart each way and the rootstocks covered to a depth of about 2 inches. For satisfactory growth goldenseal requires about 75 percent of shade during the summer, which should be provided by a lath shade or by cloth, brush, or vines. The soil should be kept free from weeds and the plants liberally watered throughout the growing season, but good drainage is necessary, since goldenseal does not thrive in boggy ground.

Under favorable conditions goldenseal reaches its best development in about five years from seed, or in a year or two less when grown from root buds or by divisions of the rootstocks. The root is dug in the autumn after the tops have withered. They are washed clean of all soil, sticks, etc., and dried on lath screens in an airy place in mild sunlight or partial shade, or indoors on a clean, dry floor. When dried in the open they should be protected from rain and dew. The cured root is kept in loose masses until marketed, since close packing may cause attacks of mold. The dried leaves and stems of goldenseal, commonly known as "seal herb," are also a marketable product.

Goldenseal root has declined greatly in market value in late years. In 1928 it was quoted at $4.75 a pound whereas in January, 1935, the price offered to growers was 75 cents a pound. On the same date the dried leaves and stems were quoted at 15 cents a pound.

HENBANE

Henbane (*Hyoscyamus niger*) is a poisonous annual or biennial herb of the nightshade family, introduced into this country from Europe and occasionally found as a weed in a number of the Northern States. The leaves, flowering tops, and sometimes the seeds are used medicinally.

Henbane is propagated from seeds, but when these are sown in the open field germination is uncertain, and a very poor stand or total failure is a frequent result. Germination is usually much more certain when the seeds are sown under glass, but the plants do not readily stand transplanting and often die after they are set in the open. Very good results have been obtained by sowing the seed in small pots under glass in January, transferring the seedlings to 3-inch pots in March, and transplanting in May to the field, where the plants may be set at least 15 inches apart in rows. In handling the plants care should be taken to disturb the soil about the roots as little as possible. The soil requirements and method of cultivation are practically the same as for belladonna.

The leaves of henbane usually suffer severely from attacks of the potato beetle, especially during the first year, and the crop is very likely to be destroyed if grown within the range of this insect.

Ordinarily the plants blossom about August of the second year and die after ripening their seed, but individual plants started early frequently bloom and set seed the first year. The leaves and flowering tops are collected when the plants are in full bloom and are carefully dried in the shade.

The American crop of henbane has never much exceeded 10 acres. The yield under favorable conditions is estimated at about 600 pounds per acre. The wholesale price in July, 1935, was 23 to 24 cents a pound.

HOREHOUND

Horehound (*Marrubium vulgare*) is a hardy perennial herb of the mint family which occurs as a common weed in many places in the United States, especially on the Pacific coast, where it threatens to become a pest. The leaves and flowering tops find some demand as a crude drug. Their greatest use, however, is in the manufacture of candy, although they are sometimes employed for seasoning.

Horehound grows well in almost any soil and thrives in light, dry soils lacking in fertility. It grows readily from seeds, which are usually sown in drills early in the spring and covered with about an inch of soil. Plants may also be started in coldframes, from either seed or cuttings, and later transplanted to the field. Propagation may also be effected by division of old plants. Plants may stand 6, 12, or 18 inches apart in the row; those which stand close together will have small stems, and hence will yield a crop of finer quality.

The plants are harvested just before flowering and should be cured in the shade in order to preserve the green color. If the stems are small, the plants may be cut close to the ground with a scythe, or with a mower if the area is large. In case the plants are tall and large they must be cut some distance above the ground and all coarse stems removed to make the herb suitable for marketing.

Yields at the rate of 2,000 pounds of dry herb per acre have been obtained. The price in July, 1935, was 7 to 8 cents a pound. In the past five years imports of horehound have ranged from 40,000 to about 100,000 pounds annually.

INSECT-POWDER FLOWERS

Insect flowers, also known as pyrethrum, from which insect powder and a number of other insecticide products are prepared, are obtained from several species of *Chrysanthemum* of the aster family, the most important of which is *Chrysanthemum cinerariaefolium*. The commercial supplies of insect flowers are produced mostly in Japan and in the Mediterranean region of Europe where this species is under cultivation. At one time it was grown commercially in California but at present only small acreages are under cultivation in Pennsylvania and Colorado.

The plant prefers a well-drained soil not too heavy and appears to be adapted reasonably well to many sections of the country. It is subject to several soil-borne diseases and cannot be grown successfully where these are present to a considerable extent. It is propagated from seed or by crown division. Direct sowing of the seed in the field is unsatisfactory, but seedlings can be grown in seedbeds and later transplanted without much difficulty. One pound of good seed is sufficient for 400 square feet of seedbed, and this area will under normal conditions provide enough seedlings to plant 1 acre. A light, well-drained soil not too acid is best suited for the seedbed which is protected with board sides 8 to 10 inches high. The seed is broadcast evenly in the bed and raked in very lightly. If necessary the bed is watered enough to keep the surface moist, but excessive water is harmful. A covering of light straw promotes germination, but a better plan is to spread cheesecloth over the frame of the bed. This prevents excessive drying of the soil and hastens germination. If straw is used it is removed when the seedlings appear, usually in 8 or 10 days, and lattice frames are placed over the bed to provide partial shade, but if the cheesecloth is used this is left until the seedlings are several inches high as it serves the same purpose. Under favorable conditions the seedlings are from 4 to 6 inches high in 6 or 8 weeks at which stage they are set in the field about 1 foot apart in rows 3 feet apart. The preferred practice is to sow the seed as early in spring as possible and permit the seedlings to remain in the seedbed until after midsummer to develop good root growth. Except in locations where the growing season is very short they are to advantage planted into the field in August, which permits them to become well established by winter. Under some circumstances the seed is sown to better advantage late in summer or in early fall and the seedlings kept in the seedbed through the winter so that transplanting early the following season is possible. Some protection of the young plants in the seedbed during the winter is sometimes necessary, depending on localities and weather conditions. The plants are well cultivated and at all times must be kept free from weeds. Fertilizers may at times be used with good results, but they must be carefully applied in accordance with local conditions and no general recommendations can be given.

As a rule no flowers are obtained the same year the plants are set in the field, but the following season a substantial crop may be expected, followed by heavier production in subsequent years. On favorable soil and with good cultural practice a planting may continue in good production for 6 or 7 years. The flowers are ready to harvest as soon as they are open, the time varying from May to July according to location. Where labor is plentiful and very cheap, as is the case in those countries where the crop is now grown extensively, the flowers may be harvested by hand picking or by simple stripping devices operated by hand, but such methods are certain to be too expensive in the United States, hence the successful growing of this crop in this country depends largely on the development of practicable and inexpensive harvesting methods. The flowers are dried by spreading them thinly on screens or wooden floors protected from the weather or in the open, in which case they are moved inside at night or during unfavorable weather. Under favorable conditions the flowers dry sufficiently in a week or 10 days so they may be bagged.

The yield of dry flowers from an acre varies greatly. When in full production 700 to 800 pounds is probably a fair average yield on a large acreage under favorable conditions, but twice that quantity has been obtained occasionally from individual fields.

The United States has imported from 4,500,000 to 13,000,000 pounds of dried flowers annually in the past 10 years. The market value has varied from 11 to 30 cents a pound. In July, 1935, the wholesale price was quoted as 17 to 20 cents.

LARKSPUR

The larkspur of the crude-drug trade is an annual plant (*Delphinium consolida*), native to southern Europe, which has long been cultivated in this country as an ornamental and is now occasionally found growing wild. Another species of larkspur (*D. urceolatum*) is native to this country and is said to have properties very similar to those of the European species. Larkspur seed is now used chiefly in remedies for external parasites.

These larkspurs thrive best in a rich sandy or gravelly soil. In heavy soils they are likely to suffer from root rot, which materially reduces the yield. A rather dry climate is suitable for plants of this character. They do not bear transplanting well and seeds should be sown in the fall or very early in the spring where the plants are to stand. The soil should be well fined and the seed thinly sown in drills spaced according to the method of cultivation to be used. When up, the plants should be thinned to stand 8 inches or more apart in the rows. The necessary cultivation consists in keeping the soil between the rows and about the plants mellow and free from weeds during the growing season.

When the seed capsules are fairly ripe, the seed is harvested by collecting the tops, which should be cut before the seed capsules have become so brittle as to risk the loss of seed by shattering and which can be handled best in the early morning while damp and pliable. They should be cured in a well-ventilated place, sheltered from rain, and when thoroughly dry may be threshed out and cleaned.

The wholesale price of larkspur seed has varied greatly. In July, 1935, it was quoted at 19 to 20 cents a pound.

The seed of a European species of larkspur (*D. staphisagria*), commonly called stavesacre, possesses medicinal properties and is recognized as an official drug. The wholesale price for stavesacre seed in July, 1935, was 40 to 42 cents a pound.

LAVENDER

The true lavender (*Lavandula spica*) is a small shrubby plant of the mint family, native to southern Europe, and widely cultivated for its fragrant flowers and for the oil distilled from the fresh flowering tops.

Lavender thrives best in light and rather dry soils well supplied with lime, but may be grown in almost any well-drained loam. On low or wet land it is almost certain to winterkill. The plant is not easily grown from seed, but may be readily propagated from cuttings or by division. In cold climates the plants must be well protected during the winter, or they may be carried over in a greenhouse or coldframe. Early in the spring the plants or rooted cuttings are set in well-prepared soil, 12 to 15 inches apart in rows spaced to suit the cultivation intended. Frequent and thorough cultivation is desirable.

Not many blooms can be cut the first year, but full crops may be expected for each of the three following years, after which it will be best to start new plantings. The flowering tops are harvested when they are in full bloom, and if used for the production of oil are distilled at once without drying. If the dry flowers are wanted, the tops are carefully dried in the shade and the flowers later stripped from the stems by hand.

On ordinary soil, yields of 600 to 1,200 pounds per acre of fresh flowering tops have been obtained. The dry weight is about four-fifths of the green weight. The yield of oil varies widely, but from 12 to 15 pounds per acre may be expected under good conditions. The wholesale price in July, 1935, for ordinary flowers was from 35 to 36 cents a pound and for selected flowers was 70 cents a pound. The quality of the oil varies greatly, as indicated by the prices quoted in July, 1935. These ranged from $2.55 to $7 a pound for oil of lavender flowers.

LICORICE

Licorice (*Glycyrrhiza glabra*) is an Old World plant, the culture of which has not succeeded commercially in this country, although the plant grows well in the arid Southwest and in California, where in some localities it threatens to become a weed. Licorice is used to some extent in medicine, and is much in demand by manufacturers of tobacco.

Licorice is a fairly hardy plant, but it thrives best in warm regions, where the season is sufficiently long to promote strong growth. Plants may be grown

from seed, but propagation by means of cuttings made from the younger parts of the rhizome, or so-called root, usually gives best results. The cuttings are set perpendicularly in deep, moist, sandy, or loamy soil, and should stand about 18 inches apart in rows so spaced as to allow for the cultivation necessary to keep the soil mellow and free from weeds.

The yield under good culture is said to average about 5,000 pounds of dry root per acre at the end of every third year. The relatively low price at which the imported root can usually be obtained has so far prevented the development of commercial licorice growing in this country. From 50 to 120 million pounds of licorice root and from one to one and a half million pounds of licorice paste have been imported annually into the United States during the last five years. The price in July, 1935, was 4½ to 5 cents a pound for ordinary root and 20 to 22 cents for selected root.

LOBELIA

Lobelia (*Lobelia inflata*) is a native poisonous annual plant, occurring generally in open woods and pastures, but is most abundant in the States east of the Mississippi River. The leaves, tops, and seeds are used medicinally.

This plant thrives under cultivation in a rather rich, moist loam, and grows well either in the open or in partial shade. It grows readily from seeds, which are very small and must be sown on soil which has been well fined and exceptionally well prepared. The seeds are sown either in the fall or in the spring in rows 2 feet apart. It is best not to cover the seeds but to sow them on the surface of the soil, which is then firmed with a float or by resting a board over the row and walking upon it. Fall planting usually gives a better stand and a heavier crop. Shallow cultivation should be given until the plants begin to flower.

Lobelia is harvested when in full flower or as soon as some of the older seed pods are full grown. The plants may be cut with a mower if the cutter bar is set high enough to avoid including the large stems. The herb should be dried in the shade, in order to preserve the green color.

Small areas have given yields at the rate of 1,000 pounds of dry herb per acre. The prices in July, 1935, were, for the herb, 16 to 17 cents; for the seed, 30 to 35 cents a pound.

LOVAGE

Lovage (*Levisticum officinale*) is a perennial plant of the parsley family introduced into this country from Europe as a garden plant and now grown as a crop in certain localities in New England and the West. The root has long been supposed to have medicinal properties and is in some demand in the drug trade. The flowering tops yield a volatile oil, for which, however, there is little demand. The seeds are used for flavoring confectionery, and the leaf stems are sometimes blanched, like celery, and eaten as a salad.

Lovage is propagated by division or from seeds. The seeds may be planted in the fall in drills 18 inches apart or sown in early spring in a hotbed, greenhouse, or well-prepared seed bed in a sheltered portion of the garden. They should be covered very lightly with sand or fine sifted soil, and in order to prevent the soil from drying out before the seeds germinate it is advisable to spread old burlap or sacking over the bed. The sacking may be sprinkled occasionally if the weather is dry and should be removed when the first seedlings break the soil. The plants should reach a size suitable for transplanting by the end of May, when they may be set at intervals of 8 inches in rows far enough apart for convenient cultivation. Lovage grows well in almost any deep, well-drained soil, such as will produce a fair crop of corn or potatoes, and is benefited by the liberal use of fertilizer, although heavy applications of manure tend to produce excessive top growth.

The roots may be dug in October of the second or third year after setting the plants. Numerous offsets will generally be found, and if these have good roots they may be used to renew the plantation without recourse to seed. Such shoots should at once be reset at the usual distances apart. The freshly dug roots should be well washed, cut into slices about one-half inch thick, and carefully dried. If necessary, artificial heat, not to exceed 125° F., may be used to hasten drying.

Returns from experimental areas indicate that a yield of about 1,000 pounds of dried root to the acre may be expected under good conditions every third year. The prices quoted for American lovage root in the wholesale drug markets in July, 1935, were 55 to 65 cents a pound.

MELISSA

Melissa, balm, or lemon balm (*Melissa officinalis*) is a perennial herb of the mint family, native to southern Europe. In this country it has long been cultivated in gardens, from which it has escaped and now grows wild in many places in the eastern United States. The leaves of balm are widely used for culinary flavoring, and the leaves and flowering tops are used in medicine. The volatile oil distilled from the plant is said to be used in perfumery and also for flavoring.

Balm grows readily on any good garden soil and is easily propagated from seeds, cuttings, or by division. The seeds may be sown in the open early in the spring, but owing to their small size it is best to sow them in shallow flats in a greenhouse or in a hotbed. The soil should be well fined and the seeds sown thinly on the surface of the soil, which is then firmed with a float or a small board. When well up, the seedlings should be transferred to deeper flats, and when 4 or 5 inches high they may be transplanted to the open and set about a foot apart in rows spaced to suit the cultivation to be given. Cultivation should be frequent and sufficient to keep the soil about the plants mellow and free from weeds.

When the plants are in full flower the crop can be cut with a scythe, or with a mower if the herb is to be used for distillation. For preparing the crude drug only the flowering tops are collected, the coarse, stemmy portions of the herb being rejected. The leaves and tops are dried in the shade in order to preserve the green color.

Yields at the rate of about 1,800 pounds of dry herb per acre have been obtained, but if only the flowering tops are collected the yield will be very materially less.

ORRIS

Orris (*Iris germanica*) is a perennial, native to southern Europe, and is cultivated chiefly in Italy for its fragrant rootstocks, which yield the orris of commerce. The plant grows well in a variety of soils and flourishes in a rich, moist loam, but roots which are grown in rather dry, gravelly soil appear to be the most fragrant. Orris is readily propagated by division of the old plants, which may be set either in the spring or in the fall about a foot apart in rows spaced conveniently for cultivation.

Since harvesting usually takes place only once in three years, the use of the land is required for that length of time in order to obtain one crop. After the roots are dug they are peeled and dried in the open air. The desired fragrance does not develop until after the dry roots have been stored for a number of months, during which time they are especially liable to the attacks of insects.

The yield is from 5 to 6 tons of dry root per acre. From 280,000 to 400,000 pounds of orris root were imported annually in the last five years. The annual importation of orris is normally about 500,000 pounds. The wholesale prices in July, 1935, were 10 to 11 cents a pound. The outlook for a profitable orris industry in this country does not appear promising, and it does not seem advisable for any considerable number of persons to undertake the growing of this crop.

PARSLEY

Parsley (*Petroselinum hortense*) is a biennial herb grown everywhere in gardens for use in garnishing and seasoning. All parts of the plant contain a volatile oil, that from the seed being especially rich in a constituent known as apiol or "parsley camphor," which is still used to some extent in medicine. In the crude-drug trade there is a small demand for the root, leaves, and seed.

A rich and rather moist soil is desirable for the growing of parsley. The seeds germinate slowly and are frequently sown early in the spring in coldframes or seed beds, from which the young plants may be removed later and set in the open in rows 12 or more inches apart and about 6 inches apart in the row. When the leaves are fully grown they may be collected and dried in the usual manner. The plants flower in the second year, and as soon as the seed is ripe it is harvested and carefully dried. At the end of the second growing season, late in October, the root may be dug and should be well washed and carefully dried. Artificial heat may be used in drying if necessary.

On small areas yields of seed at the rate of about 185 pounds per acre have been obtained. No price quotations for the seed have been available for some time, but in the past the wholesale price has varied from 10 to 70 cents a pound, according to demand and season.

PENNYROYAL

Pennyroyal (*Hedeoma pulegioides*) is an annual plant, flowering from June to October, and is found in dry soils from Nova Scotia and Quebec to the Dakotas and southward. Both the dry herb and the oil obtained therefrom by steam distillation form marketable products.

Pennyroyal grows well on average upland soils and is frequently abundant on sandy or gravelly slopes. In field planting, the seeds should be sown in rows in the fall and covered not to exceed one-quarter of an inch, since they rarely germinate if planted at a greater depth. The plants come up early in the spring, and to obtain the best results clean cultivation and freedom from weeds are essential, as with all cultivated crops.

Early in the summer, when the plants are in full flower, they may be mowed. To prepare the herb for market the plants are dried, preferably in the shade, and carefully packed immediately after drying. All the large stems should be removed in order to improve the quality of the product. The herb should be marketed promptly, since it deteriorates with age. For the production of the volatile oil, the plants should be harvested when in full flower and distilled without drying.

Returns from experimental areas indicate that a yield of about 1,200 pounds of dry herb per acre may be expected. The yield of oil varies from 15 to 30 pounds per acre. The wholesale prices quoted in July, 1935, were 11 to 12 cents a pound for the herb and $1.75 to $2.10 a pound for the oil.

PEPPERMINT

Peppermint (*Mentha piperita*) is a perennial of the mint family, frequently found growing wild in moist situations throughout the eastern half of the United States. It is cultivated on a commercial scale, chiefly on the muck lands of southern Michigan and northern Indiana and in the Pacific Northwest. The volatile oil forms the principal marketable product, but there is some demand in the crude-drug trade for the dried leaves and flowering tops.

Peppermint is propagated from "roots", or runners, which should be set in an almost continuous row in furrows about 3 feet apart and covered to a depth of about 3 inches. It can be grown on any land that will produce good crops of corn, but is most successful on the muck lands of reclaimed swamps. On uplands it soon exhausts the soil and will not do well for more than two or three seasons without the rotation of crops. On rich muck lands it will grow for a number of years, the soil being plowed after the crop is harvested and the runners turned in to form a new growth the succeeding year. It is essential that the ground be kept free from weeds, since their presence in the crop at harvest would seriously injure the quality of the oil.

When peppermint is grown on reclaimed swamps or muck lands, fertilizers are rarely needed, but on uplands it is well to plow in 12 or more tons per acre of rotted stable manure before planting. Similar applications may be made between the rows in early spring and plowed in as the land shows signs of exhaustion. Commercial truck or potato fertilizers cultivated in between the rows at the rate of 600 pounds to the acre have proved useful in keeping up fertility, but manure is to be preferred, as it provides humus or vegetable matter as well as increases the fertility.

Harvesting is begun in July or August, when the plants are in full bloom. The herb is cut and cured like hay, and when fairly well dried is placed in large vats or stills having a capacity of from 1 to 3 tons of dry herb and distilled with steam to obtain the volatile oil. The yield of oil is exceedingly variable, but on lands well suited for the production of peppermint the average yield is not far from 30 pounds per acre. The annual production of peppermint oil in the United States is about 500,000 pounds, but in some years it has been in excess of 1,000,000 pounds. During years of normal production peppermint oil may be expected to yield the growers from $3 to $4 a pound on the average, but much higher prices have been realized during periods when the production was much below normal.

In July, 1935, the wholesale price for the leaves was from 28 to 30 cents a pound and $2.40 to $2.90 a pound for the oil.

For further information on the growing of peppermint, see Farmers' Bulletin 1555, "Peppermint and Spearmint as Farm Crops."

PINKROOT

Pinkroot (*Spigelia marilandica*, fig. 7) is a native perennial herb occurring in rich open woods from New Jersey to Wisconsin and south to Florida and Texas. The root is an official drug, the use of which has declined in recent years, apparently on account of the extent to which pinkroot has been adulterated with the worthless roots of another plant known as East Tennessee pinkroot. Prospective growers of pinkroot should obtain seeds or roots for planting from thoroughly reliable sources only.

Pinkroot makes a vigorous growth under conditions suitable for growing ginseng or goldenseal, and partial shade is usually necessary, although if given a rich, moist, loamy soil it may be grown without shade in situations not too hot and dry. It is propagated either from seeds or from divisions of old roots. It is best to sow the seeds as soon as they are ripe, but if mixed with moist sand and kept in a cool place sowing may be deferred until fall or the following spring. The seeds are sown in drills 6 inches apart in well-prepared seed beds, and in the spring, when the young plants are a few inches high, they are set about a foot apart each way in the permanent beds. The old roots are divided when dormant, and each division should consist of a portion of the root with one or more buds and a number of the small rootlets. They are set in the same manner as the seedlings. Thorough cultivation and freedom from weeds are essential for good results.

Fig. 7.—Pinkroot (*Spigelia marilandica*)

The roots usually attain a marketable size in three years, but will give a heavier yield at the end of the fourth or fifth year. They are harvested in the fall, and after the tops are cut off the roots are well washed and thoroughly dried. Little can be said regarding yield, but returns from small areas indicate that a bed 4 by 30 feet will yield from 10 to 12 pounds of dry root in four years. The price in July, 1935, was 32 to 35 cents a pound.

POKEWEED

Pokeweed (*Phytolacca americana*) is a native plant of frequent occurrence in moist, rich soil along fences and in uncultivated land throughout the eastern half of the United States. The root, which is perennial, sends up large annual stems, sometimes attaining a height of 8 or 9 feet. This plant bears numerous long clusters of smooth, shining purple berries, very attractive in appearance, but the seeds are said to be poisonous. Both the root and the berries are used in medicine.

Pokeweed thrives in deep, rich soils well supplied with moisture and may be readily grown from seed sown early in the spring in rows 4 feet apart and barely covered. The seedlings may be thinned to stand about 3 feet apart in the rows. Cultivation should be shallow, though frequent. The plant develops a long, thick, fleshy root, which when old is not easily harvested and may have to be dug by hand. If the roots of plants grown from seed are harvested at the end of the first year they may be turned out by means of a deep-running plow without great difficulty. As soon as they are dug the roots are cleaned by washing and are usually cut lengthwise or transversely into slices for drying. They should be thoroughly dried, and if a large quantity is to be handled the use of artificial heat will be found desirable.

A yield of about 600 pounds of dry root per acre may be expected at the end of the first year, and three or four times as much from plants of the second year's growth. In the second year several hundred pounds of berries may also be obtained from 1 acre.

The price in July, 1935, for the dry, cut root was about 5 to 5½ cents a pound. Apparently there is but a small demand for either the roots or berries.

SAFFLOWER

Safflower, American saffron, or false saffron (*Carthamus tinctorius*) is a hardy Old World annual of the aster family, cultivated in gardens in this country for its flowers, which are used in coloring or for flavoring, and sometimes as a substitute for the true saffron.

Safflower may be readily propagated from seeds sown in the open early in the spring. The soil should be fine and mellow, and the seeds sown an inch or more apart in drills and well covered. About three weeks from the time of sowing the seed the plants will be well started, and cultivation should begin at once and be continued until the flower buds form. The plants bloom in July or August, when harvesting may begin. Only the florets are collected, and since these must be removed by hand, harvesting is slow and expensive. The plants continue to blossom for several weeks, and the florets must be harvested almost daily. It is best to collect them early in the morning and to dry them in the shade on trays having muslin bottoms. The florets should be turned daily until thoroughly dry and then stored in tin containers.

The yield is estimated at 125 to 150 pounds of dry florets per acre. The quotations for safflower in July, 1935, were 23 to 32 cents a pound.

SAFFRON

The true saffron (*Crocus sativus*) is a low-growing, fall-blooming, bulbous plant of the iris family, native to southern Europe, where it is cultivated commercially. It was formerly grown as a small garden crop in some localities in this country, chiefly in Lancaster and Lebanon Counties, Pa. The stigmas of the flowers form the saffron of commerce. Saffron is used in cookery and for coloring confectionery, and was formerly widely used in medicine.

A rich, well-drained garden soil favors a vigorous growth of the plant, but a better quality of saffron is obtained on land of medium fertility. It is propagated from bulbs (corms), which may be planted in August about 6 inches apart each way and 6 inches deep in well-prepared soil. When grown on a large scale the bulbs are often set late in the spring. The ground is laid off in rows about 20 inches apart, and a furrow 6 to 8 inches deep is opened for each row. In this furrow the bulbs are set in two parallel rows about 4 inches apart and about 2 inches apart in the row. The furrows are then filled and the surface of the soil brought to a uniform level. Thorough cultivation and freedom from weeds are essential for good results.

The purplish blossoms usually appear about October, but the main leaf growth of the plant is made in the following spring. The bulbs may remain undisturbed for three or four years, or they may be taken up yearly and the clusters divided. All unsound bulbs should be rejected, as they are often attacked by a fungus which readily spreads to the sound bulbs, causing them to rot. During the blossoming period, which frequently lasts from two to three weeks, the flowers are collected daily just as they open. The orange-colored stigmas are then removed from the flowers, either by pulling them out or by cutting them off with the finger nail, after which the flowers are thrown away. The stigmas are dried immediately, a common method being to spread them in a thin layer on a sieve which is suspended over a low fire. When fully dry they are placed in linen bags and stored in a dry place.

The yield of saffron is variously estimated at from 10 to 30 pounds per acre, according to the situation where it is grown. About 50,000 flowers are required to produce a pound of dry saffron; consequently, the amount of hand labor involved in removing the stigmas is quite large. The prices in July, 1935, ranged from $9.50 to $9.75 a pound. Owing to the high cost of production, it is not thought probable that saffron culture would prove profitable in the United States.

SAGE

The common sage plant (*Salvia officinalis*) is a hardy perennial of the mint family, widely cultivated in gardens, and when once established it persists for several years. The leaves are used extensively for seasoning meats and soups, and a tea made from them is an old household remedy.

Sage is easily cultivated and will grow in any well-drained fertile soil, but seems to thrive best in a rich clayey loam. For cultivation on a large scale the seeds are sown in early spring in rows from 2 to 3 feet apart, and when the plants are well up they are thinned to stand about 12 inches apart in the row.

Seedling plants have a tendency to produce narrow leaves; hence, the broad-leaved varieties which do not flower readily are the most desirable, since they give a larger yield of leaves. As the plants rarely set seed, they are usually grown from cuttings, which may be obtained from seed houses having their own propagating gardens. Cuttings set as early in the spring as weather conditions will permit usually give a large crop. In the North the plants should be protected in winter by a mulch of manure. Sage may also be grown as a second crop after early vegetables.

A fair crop of leaves may be harvested the first season and a much larger one for five or six years following. Only one picking should be made the first year, after which two or three pickings may be made in a season. If a product of fine quality is desired, the leaves are picked by hand and dried in the shade. Sage leaves are apt to turn black while drying unless the removal of moisture proceeds continually until they are fully dry. A cheap grade may be obtained at a smaller harvest cost by cutting the plants with a mower, the cutter bar of which is set at such a height as not to include the woody stems. The dry herb should be marketed promptly, since it loses its strength rapidly with age.

FIG. 8.—Seneca snakeroot (*Polygala senega*)

Returns from experimental areas indicate that on good soil a yield of 2,000 pounds or more of dried tops per acre may be expected. In case the leaves only are harvested, the yield will be proportionately less. American leaf sage usually brings a considerably higher price than that imported from Europe. It is not now grown to the same extent that it was some years ago, and no prices are quoted at the present time for the American product. Dalmatian sage was quoted at 4¼ to 5 cents a pound in July, 1935.

SENECA SNAKEROOT

Seneca snakeroot, known also as senega or seneca root (*Polygala senega*, fig. 8), is a small native perennial, occurring in rocky woods in the eastern United States and Canada. Seneca is not yet grown on a commercial scale, although cultivated experimentally in a number of places. The root is used in medicine.

Seneca can be grown in good garden soil or in rather firm, stony soil provided the soil contains a fair proportion of leaf mold or very well rotted manure. Shade is not essential, although the plant thrives in partial shade or under modified forest conditions. Roots for propagation may be obtained from dealers or may be collected from the wild in autumn or early spring. If set 15 inches apart in rows, the plants may be readily cultivated until they reach a marketable size. The seeds ripen in June and may then be planted, or they

may be stratified by mixing with sand and buried in boxes or flowerpots in moist soil until the following spring, when they may be sown in seed beds or shallow boxes of loam and leaf mold. The seedlings when old enough to be handled safely may be transplanted to the permanent beds and set in rows to facilitate cultivation. In cold situations they will probably need to be protected during the first winter after transplanting. A light covering of straw or pine needles will be sufficient to protect them from severe frost.

The plant is slow in growth, and experiments thus far indicate that about four years are required to obtain marketable roots. The roots should be dug in the fall, thoroughly cleaned, and dried. There are no reliable data on the probable yield. Seneca root is in constant demand and wholesale prices were quoted in July, 1935, at 27 to 28 cents a pound.

SERPENTARIA

Serpentaria or Virginia snakeroot (*Aristolochia serpentaria*) is a native perennial plant occurring in rich woods in the eastern part of the United States, and most abundantly along the Allegheny Mountains. The roots of this plant are used in medicine.

Like many other woodland plants, serpentaria requires a rich, moist loam and partial shade for its best development. It may be readily propagated from seeds, which, however, require several months for germination. The seeds are best sown in a well-prepared seed bed as soon as they are ripe. They may also be sown broadcast or in drills 6 inches apart and lightly covered with leaf mold. A thin mulch of straw or leaves will afford the necessary winter protection. In the spring the plants may be set 6 inches apart each way in the permanent beds. Plantings have been made in the open, in which case the plants were set 4 inches apart in rows 16 inches apart, but the results have been less satisfactory than with plantings made under shade.

The roots are collected in the fall, thoroughly cleaned, and carefully dried. Satisfactory data on probable yields under cultivation are not available. The present price ranges from 46 to 47 cents a pound.

SPEARMINT

Spearmint (*Mentha spicata*) is a well-known perennial of the mint family which is very frequently found growing wild in moist situations throughout the eastern half of the United States. It is widely used for seasoning meats, and the leaves and flowering tops, as well as the volatile oil distilled from the whole herb, form marketable drug products.

Spearmint is easily grown in any fertile soil which is fairly moist. Its culture and the method of distilling the volatile oil are the same as for peppermint. To prepare the dry herb for market the leaves and flowering tops are collected when the first flowers appear and before the leaves begin to fall and are carefully dried in the shade. The demand for the dry herb is small, but the annual market requirement for the oil is about 50,000 pounds.

On ordinary soils the yield of oil varies from 10 to 20 pounds per acre, according to stand and season, but on muck lands the yield is usually only a little less than that of peppermint. The price of the oil under normal conditions averages about $3 to $3.50 a pound. The dry herb was quoted in July, 1935, at 35 to 45 cents a pound.

For further information on the growing of spearmint, see Farmers' Bulletin 1555, "Peppermint and Spearmint as Farm Crops."

STRAMONIUM

Stramonium, Jamestown weed, or jimson weed (*Datura stramonium*), is a poisonous annual of the nightshade family, which occurs as a common weed in almost all parts of this country except the West and the North. The leaves and seeds are used medicinally.

Although stramonium grows wild on a variety of soils, it thrives best under cultivation in rich and rather heavy soils which are fairly well supplied with lime. It grows readily from seed, which may be sown in the open early in the spring in drills 3 feet apart and barely covered. When the plants are well established they are thinned to stand 12 to 15 inches apart in the row. The plants can be readily transplanted, and gaps occurring in the rows may be filled in with the plants removed in thinning. Cultivation sufficient to keep the soil free from weeds is necessary for good growth.

Cultivated plants are frequently attacked by leaf-eating insects, especially in the early stages of growth, and it is often necessary to use lime or other insect repellents to prevent the destruction of the crop.

The leaves, which are collected when the plant is in full bloom, may be picked in the field, but time will be saved if the entire plant is cut and dried in an artificially heated curing room at a temperature of 100° to 110° F. When the leaves are dry they can be readily stripped from the stems, and should be baled for shipment. Such seed as is ripe may be easily threshed out of the capsules after the leaves have been removed from the stems.

Yields of dry leaf at the rate of 1,000 to 1,500 pounds per acre have been obtained. The yield of seed is much more variable, and is estimated to range from 500 to 2,000 pounds per acre. The price in July, 1935, for the leaves was 10 to 11 cents and for the seed 9 to 10 cents a pound.

TANSY

Tansy (*Tanacetum vulgare*) is a European perennial plant, long cultivated in this country in gardens, from which it has escaped, and it now occurs as a weed along fence rows and roadsides. The leaves and flowering tops are in some demand for medicinal purposes. The herb also yields a volatile oil, for which there is a small market.

Tansy grows well on almost any good soil, but rich and rather heavy soils well supplied with moisture favor a heavy growth of herb. It may be propagated from seed, but is more readily propagated by division of the roots early in spring. The divisions are set 18 inches apart in rows 3 feet apart. Seed may be sown very early in the spring in the open or in seed beds, and the seedlings later transplanted to the field. Such cultivation as is usually given to garden crops will be sufficient.

The plants are cut late in the summer when in full flower, the leaves and tops being separated from the stems and dried without exposure to the sun, as the trade desires a bright-green color. For the volatile oil the plants are allowed to lie in the field after cutting until they have lost a considerable portion of their moisture. They are then brought to the still and the oil removed by the usual method of steam distillation.

A yield of about 2,000 pounds of dry leaves and flowering tops per acre may be obtained under good conditions. The yield of oil varies, but about 20 pounds per acre is a fair average. In the United States the center of production of oil of tansy is Michigan, where about 2,500 pounds are distilled annually. The price of the oil in July, 1935, was $1.85 to $2 a pound. On the same date the wholesale price for leaves was 18 to 20 cents a pound.

THYME

Thyme (*Thymus vulgaris*) is a shrublike perennial plant of the mint family, native to southwestern Europe. It is a common garden plant, which lives for many years under good culture. The herb, often used for seasoning and flavoring, yields the oil of thyme, which has well-recognized medicinal properties.

Thyme grows well from seed, which may be sown early in the spring in drills 3 feet apart, or the plants may be started in a greenhouse or in seed beds outside and later set at intervals of about 18 inches in rows 2 to 3 feet apart. Thyme may also be propagated, like geraniums, from cuttings rooted in sand under glass. The plants grow well in mellow upland soil of good quality, and should be well cultivated and kept free from weeds throughout the growing season.

For preparing the dry herb only the flowering tops are used, and these are cut when the plant is in full bloom and carefully dried in the shade in order to preserve the natural color. The volatile oil is obtained from the entire herb, which is preferably cut when in full flower and subjected to steam distillation without previous drying.

Returns from experimental areas have shown great variations in the yield, which has averaged about a ton of green herb per acre. Normally the yield from a planting increases for several years, as the plants become better established, and yields at the rate of about a ton of dry herb per acre have been reported. The wholesale price in January, 1927, for the dry herb ranged from 10¾ to 11 cents a pound; for the imported oil, from 68 cents to $1.45 a pound, according to quality.

VALERIAN

Valerian (*Valeriana officinalis*) is a hardy herbaceous perennial, well known under the name of "garden heliotrope" and often grown as an ornamental plant. It has also been cultivated as a drug plant in New York and in parts of New England. The dried roots (rhizome and roots) form the marketable drug.

Valerian grows well in all ordinary soils, but thrives in a rich and rather heavy loam which is well supplied with moisture. It may be readily propagated by dividing the old roots, either in the fall or in the spring, and setting the divisions about a foot apart in rows 2 to 3 feet apart. If the divisions are set very early in the fall in time to become well established before frost, a good crop may usually be harvested the following autumn. Plants may also be grown from seed, which are preferably sown as soon as they are ripe in well-protected seed beds in the garden. Early in the spring the seedlings may be transplanted to the field and set at the same distances apart as the divisions of the root. Growth will be favored by a liberal application of farmyard manure, which should be well worked into the soil before the plants are set out. Thorough cultivation is essential.

The roots of the plants propagated by division may be dug in the fall of the first year's growth, although the yield will probably be small. Those of seedling plants do not usually reach a size suitable for harvesting before the end of the second growing season. After digging, the roots are washed, preferably in running water, until all adhering soil is removed. Washing and drying will be facilitated if the thick portion of the roots is sliced lengthwise. The drying should be very thorough, and the use of artificial heat will be found advisable.

Under good conditions a yield of 2,000 pounds or more of dried roots per acre may reasonably be expected. The wholesale price in July, 1935, ranged from 19 to 20 cents a pound.

VETIVER

Vetiver or cuscus grass (*Vetiveria zizanioides*) is a perennial of the grass family, native to southern Asia. It is occasionally cultivated in this country in the warmer portions of the Gulf Coast States as an ornamental and also for its aromatic roots, which are often used to impart a fragrance to clothing. In other countries an oil is distilled from the roots and used in the manufacture of perfumes.

Vetiver will grow in almost any soil, but light, sandy soil enriched by farmyard manure is to be preferred. Propagation is effected by dividing old clumps, which may be set in the field, in either the fall or spring, about 4 or 5 feet apart each way. During the growing season the plants are given sufficient cultivation to keep them free from weeds. Vetiver grows in close bunches from 6 to 8 feet high, the numerous roots spreading horizontally about 2 feet on all sides of the plant.

Harvesting the roots, which usually takes place in November, is a laborious operation. The soil about the plants is opened with a stout, sharp spade in a circle large enough to include most of the roots. The earth is then dug from beneath the center of the plant and the entire clump lifted. The roots are first beaten or shaken to free them from adhering soil, then cut off close to the root crown and thoroughly washed. They may be dried in the open air, but it is preferable to dry them in a closed room at a low temperature, since they lose in fragrance if exposed to the hot sun or to a free circulation of air.

Yields at the rate of 600 to 1,000 pounds of dry roots per acre have been obtained. In former years vetiver root sold in the markets of New Orleans at from 75 cents to $1 a pound, but at the present time price quotations are not available. The oil, which is not produced commercially in this country, was quoted in July, 1935, at $12.75 to $14 a pound. The demand for both roots and oil is small, and it has not yet been shown that vetiver would be a profitable crop in the United States.

WINTERGREEN

Wintergreen (*Gaultheria procumbens*) is a low-growing, broad-leaved, evergreen plant with a creeping stem. The shoots from this stem grow to a height of 4 to 5 inches and bear solitary white flowers, which are followed by red berries. These berries are edible and are widely known as teaberries or

checkerberries. Wintergreen is a common plant in woods and clearings from eastern Canada southward to the Gulf States, but its collection in quantity is somewhat difficult. Both the dry herb and the oil form marketable products.

Like other woodland plants, wintergreen thrives only in partial shade, and plantings should be made in a grove or under a specially constructed shade, such as is used for ginseng or goldenseal. A fairly good growth may be expected in soil which is thoroughly mixed with leaf mold to a depth of 4 inches or more. Wild plants may be used for propagation. Divisions of these may be set in the fall or spring, about 6 inches apart each way, in permanent beds.

Wintergreen is usually gathered in October or at the end of the growing season. The plants are carefully dried and packed in bags or boxes for marketing. For the production of the volatile oil the plants are soaked in water for about 24 hours and then distilled with steam. Over 22,000 pounds of wintergreen oil was produced in this country in 1909, and 6,000 pounds in 1914. Since then the production has continued to decline gradually but no actual figures are available.

In July, 1935, the wholesale quotations for northern oil were from $4 to $8 a pound, and for southern oil, $2.65 to $3.75 a pound. Collectors in the past received about 5 cents a pound for the herb. The results of numerous trials indicate that, on account of the small yield, wintergreen production under cultivation is not likely to be profitable at the prices quoted.

WORMSEED, AMERICAN

American wormseed (*Chenopodium ambrosioides anthelminticum*) is a coarse weed, occurring commonly in waste places and often in cultivated ground throughout the eastern and southern parts of the United States. The seeds (fruits) and the volatile oil distilled from the tops of the plant are employed in medicine.

This plant grows well under cultivation in almost any soil, but a good sandy loam is preferred. It is now cultivated for oil production only in a small area in Carroll County, Md. The seed is sown in well-prepared beds about March 1, and between May 15 and June 15, when the seedlings are 4 to 5 inches tall, they are transplanted and set about 10 inches apart in rows about 3 feet apart. The soil is kept entirely free from weeds by shallow cultivation throughout the growing season.

Harvesting is usually begun early in September or as soon as the seeds have taken on a black color, but before the plants have turned brown. If harvesting is delayed until the plants are fully mature there will be considerable loss through shattering and a diminution in the yield of oil when they are distilled. The crop may be harvested with large knives or sickles, either by cutting off the entire plant at the ground or by cutting the branches separately. The latter method saves the labor of handling a quantity of useless woody material and also requires a smaller still capacity to handle the crop. After cutting, the plants are laid out on the ground in rows and allowed to cure for about three days before they are distilled, but when large acreages are grown a mowing machine is used to advantage.

In the South wormseed has been grown successfully as a seed crop. The ground is prepared in February and laid off in rows about 4 feet apart. A furrow is opened in each row, in which a complete fertilizer is applied at the rate of 400 to 500 pounds per acre. The soil on each side of the row is thrown in with a turnplow, forming a low ridge, which is then flattened with a light roller. The seeds are sown on this ridge with a drill. The plants are thinned to stand 18 inches apart in the row and are given frequent shallow cultivation.

The crop should be ready for harvesting late in July or early in August and should be cut before the tops begin to take on a brown color. The plants are cut with either a mower or an old-style grain reaper and are left in the field until thoroughly dry. They may be housed and the seed threshed out when convenient, but, since the seeds shatter easily, waste will be avoided if the plants are thrown upon large canvas sheets and the seed threshed out in the field. The seed is light and not easily cleaned, but wire sieves of suitable mesh have proved very satisfactory for this purpose.

The yield of seed per acre averages about 1,000 pounds. The yield of oil varies, but under favorable conditions about 40 pounds per acre is regarded as a fair average. The annual production of the oil has varied greatly, but no accurate records are available. Some reports indicate that in some years as

much as 70,000 pounds have been produced, but this is probably considerably in excess of the market requirements.

Wormseed was quoted in July, 1935, at 6 to 7 cents a pound. The price of the oil in recent years has ranged from $2 to $6 a pound, according to the amount produced.

WORMWOOD

Wormwood (*Artemisia absinthium*) is a hardy herbaceous Old World perennial of the aster family, which has escaped from cultivation in this country and now occurs as a weed in many localities in the southern part of the United States. For many years it has been grown commercially on a small scale, chiefly in Michigan and Wisconsin. The dried leaves and tops have long been used medicinally, but the volatile oil distilled from the plant now forms the principal marketable product.

Wormwood will grow in almost any soil, but the best results are to be expected in deep, rich, moderately moist loams. The seeds are frequently sown broadcast early in the fall, following a grain crop; but if the plants are to be cultivated it is best to start them from seeds sown in seed beds early in the spring or from cuttings of the young shoots taken in the spring and rooted in sand under glass or in the shade of a lath shed. The seeds are very small and should be sown on the surface of the soil in coldframes or seed beds and lightly covered with very fine sandy soil. The plants are easily handled and may be transplanted in moist weather with good results at almost any time during the growing season. They are set about 18 inches apart in rows 3 or 4 feet apart and are well cultivated. The soil should be kept absolutely free from weeds, since their presence in the crop at harvest time seriously damages the quality of the oil. A fair cutting of the herb may be expected the first year after planting and full crops for two or three successive seasons, after which new plantings will be found more satisfactory.

The plants are harvested when in full bloom and may be cut with a scythe, or a mower may be used if the area is large. While still fresh, the plants are distilled with steam to obtain the volatile oil. To prepare the leaves and flowering tops for market they are stripped from the stems by hand after the plants are cut and carefully dried in the shade without the use of artificial heat.

Experimental plantings have given yields at the rate of 2,000 pounds of dry tops or 40 pounds of oil per acre. When grown on a commercial scale the yield of oil appears to average about 20 pounds per acre.

The oil was once used extensively in the manufacture of absinth, but when the use of this product was restricted in 1912 the demand for the oil fell off and the price declined, until in the early part of 1915 it reached the low level of $2 a pound. Since then the price has varied greatly. In recent years it has again been at a low level. In July, 1935, the quotations were from $2.75 to $3.25 a pound. Owing to the limited use of this oil, there appears to be little room for further profitable expansion of this industry.

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THE FIELD FOR DRUG-PLANT BREEDING.

DR. W. W. STOCKBERGER, PHYSIOLOGIST IN CHARGE OF DRUG-PLANT INVESTIGATIONS, BUREAU OF PLANT INDUSTRY, U. S. DEP'T OF AGRICULTURE.

In the decade which has just passed great advances have been made in the knowledge of breeding, and during the same period the practical service which breeding has rendered in the field of plant production has come to be very generally recognized and appreciated. The art of the plant breeder has now been exercised upon a large number of the plants from which materials for food or clothing are obtained or which serve for ornamental and decorative purposes, and as a result the number of new or improved varieties and strains of useful plants has been enormously increased.

In the face of all this progress the fact that, with a few notable exceptions, our medicinal plants have been almost entirely neglected by plant breeders seems to deserve an explanation. A brief statement, therefore, of the probable causes of delay in the inclusion of medicinal plants among the subjects of the plant breeder's art, and of the possibilities which the exploitation of this field seems to offer may be of more than passing interest to pharmacists generally.

Although the term breeding has become very familiar in recent years, a brief statement of the sense in which it is used in this discussion may contribute somewhat to clearness. The improvement of a plant, the object of which is to render it more serviceable to the purposes of man, may be effected by continually selecting for propagation such plants as conform most closely to the ideal sought, by the selection of spontaneous variations or sports, by the isolation and live breeding of forms presenting morphological variations, by the breeding of the so-called ever-sporting varieties, and by hybridization. Other methods of procedure might be mentioned but those just named will serve to indicate some of the various avenues through which the problem of plant improvement may be approached, and to gage the wide sense in which breeding is used in this paper in contrast to a narrow usage occasionally encountered which restricts the term to changes produced in plants as a result of sexual reproduction.

It was long since recognized that the medicinal qualities of plants are easily affected by culture, but practical breeders have been very slow to avail themselves of this knowledge. There can be little doubt that this failure to grasp the opportunity presented was largely due to the fact that the criteria of progress in medicinal plant breeding are of an order almost entirely unlike that which

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includes the standards of fitness commonly employed by plant breeders. Such standards are usually based upon characteristics which are readily perceived by the senses, e. g., form, size, color, odor, agreeableness to the taste; or by those which are readily estimated by simple physical means, e. g., weight of yield, strength of fiber, hardness of grain; or again by those characteristics estimated by comparison, e. g., hardiness, resistance to disease, drought, etc. On the other hand, the characteristics which the breeder of medicinal plants must use as his main guide can be determined only through the use of the technique and methods of the pharmaceutical chemist or of the pharmacologist. Probably few, if any, of the practical breeders have either the inclination or necessary skill for the estimation of the active principles which condition the value of medicinal plants, and the natural result is that their activities are directed along other lines.

A second cause for the small consideration given to medicinal plant breeding may be found in the disparity which exists between cultivated drug plants and many other economic plants with respect to their importance as marketable products. It is but natural that plants which have long been widely cultivated or which possess great commercial possibilties should be among the first to attract attention to the desirability of their improvement.

A third but by no means unimportant consideration is the relatively imperfect state of our knowledge with respect to the essential facts concerning the cultural requirements of many drug plants and the prevailing uncertainty as to the possible modifications in the nature or quantity of the active constituents of these plants which may be induced by variations in soil, climate or other environmental factors.

It may be well at this point to disavow any intent in the foregoing paragraphs to disparage in any way the very creditable work that has been done in recent years along the line of drug plant breeding, or to disregard the fact that the cultivation of a small number of drug plants has been successfully carried on in several localities in this country. On the contrary the object has been to show that as a whole medicinal plant breeding is as yet largely an untried field.

In this as in other new fields of endeavor it is advisable to heed the homely proverb, "make haste slowly," and misguided enthusiasm must not be mistaken for ability to produce practical results. The practical breeder will hesitate long before undertaking a line of work which may require years of time and the outlay of thousands of dollars to bring it to completion. First of all he will seek to establish an *ideal*, a clear cut mental picture of the end to be attained. This ideal will be a composite built up from a definite understanding of what is required, and from a thorough knowledge of the relationships and the morphological and physiological characteristics of the species which he is seeking to improve. The formation of these ideals must be preceded by a period of experimentation and study in order that the breeder may become familiar with the nature, requirements, adaptability and behavior of the plants in question. This preliminary course is all the more necessary since many of the medicinal plants upon which the breeder must work have been brought to this country from foreign lands, and many more which are indigenous here must be brought under cultivation in the course of which they may be expected to undergo certain modifications.

In the opinion of the writer the constructive work of the immediate future in the field of drug plant breeding will consist largely in extending our knowledge of the chemical constituents of these plants, in determining the relative value and relationship of their various characteristics and in fixing standards of breeding which will lead to definite economic results. Then as pharmaceutical chemistry leads the way and gives us further information concerning the nature of the active principles, there is every reason to believe that the selection of different pure lines of superior potency and their subsequent hybridization will result in the attainment of standards of production far in advance of those to which we are accustomed.

The work of the Bureau of Plant Industry on medicinal plant breeding was inaugurated by Dr. R. H. True, formerly Physiologist in Charge of Drug Plant Investigations. That he early recognized the necessity for a thorough preliminary study of the materials later to be used in breeding is evident from a paper prepared by him in 1906, in which with reference to breeding drug plants he says, "The pioneer work of finding out the necessary preliminary facts concerning culture methods and the demands made on soil and climate is only now being done. As soon as these fundamental conditions are fairly well understood, the cultivator will be in a position to refine and increase his product by the application of new methods." In harmony with the principle here expressed, the work has since been consistently carried on and in the Office of Drug Plant Investigations two correlated lines of work are now in progress, one a series of laboratory studies on the quantitative variation of the active constituents in a number of plants, and the other a series of comparative cultural tests conducted in widely separated localities.

The character of the laboratory investigations is well illustrated by the paper by Mr. A. F. Sievers, entitled, "Individual Variation in Belladonna Plants as a Basis for Improvement by Selection," and by that of Mr. Frank Rabak entitled, "The Effect of Geographical Source on the Volatile Oil of Hops," both of which have just been presented for your consideration. The cultural tests carried on at the several field stations have for a common object the determination of the fitness of a large number of drug plants for the conditions offered by each locality, a study of the possibility of bringing under cultivation various wild plants yielding important drugs, the selection of strains or individuals which promise to serve as valuable material for the further purposes of breeding, and the acquiring of data relative to the localities of situations offering the most favorable economic conditions for the commercial production of certain medicinal plants.

At Madison, Wisconsin, where the Office of Drug Plant Investigations is conducting its investigations in co-operation with the University of Wisconsin, there are now under observation approximately forty-five species of which belladonna, henbane, stramonium, a number of the mints, cannabis and grindelia may be mentioned. At the two stations located near Washington the number of species being studied is much larger. Here some solanaceous species and others yielding valuable essential oils are receiving special attention. A study of the perfume roses is also in progress, the purpose of which is to select and improve the varieties best suited for the production of oil of rose in this country.

At Timmonsville, S. C., the work is largely concerned with cannabis, species of capsicum and a few oil bearing plants. In Florida, where the station is at present located at Orange City, we find one of the most interesting parts of our field. Here the opportunity for the selection and improvement of plants yielding essential oils is very promising and the data so far secured with respect to camphor, monarda, rose geranium, lemon grass, citronella grass, and a number of other species clearly show that further important results will be obtained by continuing the present line of investigations. For example, strains of *Monarda punctata* have been developed by selection which give an unusually high yield of an oil containing the valuable constituent thymol. We are now seeking to increase the percentage of thymol in the oil through suitable modifications in the conditions of growth of this plant.

To extend this discussion further would perhaps be a presumption upon privilege but if the remarks just made on the work of the Office of Drug Plant Investigations have suggested something of the scope of the field of Drug Plant Breeding, the purpose of this paper is fulfilled. It may be permitted to say in closing that the breeding of medicinal plants not only offers much in a very practical way but also affords a field for the greatest scientific activity.

THE PAPAIN OF COMMERCE.

WILLIAM MANSFIELD, NEW YORK.

Much has been said and written about papain, yet much more needs to be said and written about it before its adulteration can be stopped, and before it will be possible for it to occupy the place in our materia medica that it should.

Papaw—*carica papaya*—is a tree cultivated in southern Florida, tropical America, and in all tropical countries. It is supposed that the parent trees from which the present cultivated forms were derived originally grew wild in the West Indies. In proof of this, it is definitely known that the papaw tree was not known in India and other tropical countries before the discovery of America. Under favorable conditions a tree grows to a height of twenty feet. The unbranched trunk is light green and smooth, except for the leaf scars. The leaves are light green above, paler beneath, five to seven lobed, the lobes again divided into smaller lobes; the petioles of the leaves are frequently 1.5 dm. long. The leaves occur in greatest numbers at the top of the stem where they stand nearly erect. The older, larger leaves droop and finally fall away as the trunk increases in length. There are three types of flowers borne on as many different trees. The fragrant staminate flowers are in slender pannicles, one to three dm. long; the calyx 1.5 mm. long; the corolla is saucer shaped, 3 cm. long; the slender tube is dilated at or near the top. The lanceolate lobes of the corolla are shorter than the tube. The ovary, if present, is rudimentary and no stigma is developed. The pistillate flowers occur singly or in groups of two or three. The calyx is about 5 mm. long and does not fall off after fertilization. The lanceolate petals stand erect to a height of 2.5 cm. The egg-shaped ovary is bluntly five-angled. The perfect flowers are bell-shaped, the lobes standing erect.

GINSENG CULTURE

By W. W. Stockberger, *principal physiologist in charge, Office of Drug, Poisonous, and Oil Plants, Bureau of Plant Industry* [1]

Contents

INTRODUCTION

GINSENG is a native product of recognized importance. The export trade in dry roots has existed for more than a century and for the last 10 years has attained an average value of about $1,000,000.

The natural production of ginseng, diminished by overcollection and the contraction of suitable forest areas, has dwindled to such an extent that prices have risen to levels warranting cultivation, which has proved successful in judicious hands. The plant, however, has little domestic value except for the exploitation of amateur cultivators and depends on a distant oriental market (China) for its standing as a commodity. As a commercial product it would appear particularly liable to overproduction, which danger, however, is greatly lessened by the slow development of the plant and the inherent difficulties of its cultivation.

Under the present conditions of production ginseng offers attractive possibilities to patient cultivators who appreciate the limitations of growth and the slow development of woodland plants in general and are willing to make a material outlay with only scanty returns in view for several years to come, but it holds out no inducement for inexperienced growers looking for quick profits from a small investment.

The culture of ginseng and of special crops generally is best begun in an inexpensive and experimental manner, enlarging the equipment only as reasonable success seems assured. "Plunging" in ginseng is likely to prove disastrous as in other forms of business.

Ginseng is adapted best to the Northeastern, North Central, and North Pacific Coast States and can also be grown successfully in the Appalachian Mountain region. Its culture is not recommended for the South, the Great Plains, or the Southwest.

[1] Revised by A. F. Sievers, senior biochemist, Division of Drug and Related Plants.

THE GINSENG PLANT

American ginseng (fig. 1), botanically known as *Panax quinquefolium* L. of the family Araliaceae, is a fleshy rooted herbaceous plant, growing naturally on the slopes of ravines and in other shady but

FIGURE 1.—Branch, root, flower and berries of American ginseng.

well-drained situations in hardwood forests, in varying abundance from Maine to Minnesota and southward in the mountain regions to the Carolinas and Georgia. In its wild state it grows from 8 to 20 inches high, bearing 3 or more compound leaves, each consisting of 5 thin, stalked, ovate leaflets, pointed at the apex and rounded

or narrowed at the base, the 3 upper leaflets being larger than the 2 lower ones. A cluster of from 6 to 20 small greenish-yellow flowers is produced in midsummer, followed by as many bright-crimson berries, each containing from 1 to 3 flattish wrinkled seeds the size of small peas. The berries of northern ginseng rarely contain 3 seeds, but in southern ginseng berries containing 3 seeds are very common.

The root is thick, spindle-shaped, 2 to 4 inches long, and ½ to 1 inch or more in thickness, in the older specimens generally branched and prominently marked with circular wrinkles. Branched roots of the wild Manchurian and Korean ginseng having some resemblance to the human form are said to be in particularly high favor in China, but this feature gives no special value to American ginseng. The seeds (fig. 2) are slow in germination and should never be permitted to become dry. As soon as they are gathered they should be mixed with twice their bulk of moist sand, fine loam, sawdust, or woods earth, and stored in a damp, cool place until they are planted. As a rule the seeds do not germinate until a year from the spring following their ripening, and this fact must be borne in mind in purchasing seed for planting.

Figure 2.—Seeds of American ginseng (natural size).

Ginseng seedlings grow about 2 inches high the first year, with 3 leaflets at the apex of the stem. The second-year plants may reach a height of 5 or 6 inches, bearing 2 compound leaves, each composed of 5 characteristic leaflets. A third leaf is generally added the next year, when fruits may be expected. In succeeding years a fourth leaf is formed, and the fruiting head reaches its maximum development. A single plant of southern ginseng sometimes produces as many as 300 seeds, but northern ginseng very rarely produces more than 100 seeds to the plant, and under cultivation, the average seldom exceeds 40.

VARIETIES

There are various recognizable geographical races of American ginseng, not all of which are of the same value to the grower. Plants from the northern range, particularly those indigenous to New York and Wisconsin, appear to possess the most useful characteristics and form the best basis for breeding stocks. Southern ginseng, though vigorous and forming roots of good size and shape, does not seed well at first in northern localities, but after a few years it becomes adapted to the climate and will mature seeds before frost. Some of the western types have long, thin roots of undesir-

able character, and another local form, dwarf in growth, has small, round, and almost worthless roots. The beginner should endeavor to procure from reliable dealers the best commercial types of ginseng as a foundation for his breeding stock.

The culture of native ginseng has been too brief to induce varietal changes, but liberal fertilization and continual selection of seeds from individual plants having superior commercial characteristics will doubtless in the end favorably modify the wild type of plants.

SUITABLE SOILS

Soil and location are very important in the culture of ginseng, as it is a plant that grows naturally on the slopes of ravines and in other well-drained situations where the soil is formed from the acid leafmold of hardwood forests. The soil should be naturally dry, fairly light, and in a condition to grow good vegetables without the addition of strong manure. An absolutely new soil with the best of natural drainage is to be preferred. Very sandy soil should be avoided, as it tends to produce hard, flinty roots of inferior value. Although almost any fairly good soil can be brought into a condition suitable for ginseng by proper treatment, the cost of satisfactory sterilization is usually heavy. In numerous cases the addition of leafmold from hardwoods has given best results, since ginseng requires an acid soil. For seedbeds the soil should be half woods earth free from fiber, and, if it is inclined to be heavy, enough sand should be added so that the mixture will not bake or harden even after heavy rains.

GROWING THE CROP

Before the diseases of ginseng became such a menace to the industry, practical growers advised the starting of ginseng plantings with both young roots and seeds. By planting roots 3 or more years old a moderate seed crop may be had the first year, and a stock of 1-year or 2-year roots set at the same time will start the rotation which is necessary to provide for a marketable crop of roots each year after the first crop is harvested. However, the grower who purchases roots for planting incurs the risk of introducing diseases into his bed, and it appears to be the better policy not to take chances with roots but to depend entirely upon seeds.

Ginseng seeds are advertised for sale by many of the older growers and are usually procurable at prices varying from 50 cents to $1.50 per thousand. Seeds are often sold by weight, and it is estimated that 1 pound of average northern seed should produce 7,000 to 8,000 plants, and 1 pound of average southern seed 10,000 plants or more. Stratified seeds usually cost more than fresh seeds, but are regarded as far more satisfactory. Dealers almost invariably supply seed that is at least a year old unless new seed is specially requested. As the output of seeds is likely to become greater than is necessary to extend the plantation, it is well to restrict seed production by nipping the flower heads unless a good market for the seeds is assured. Roots gain more rapidly in size and weight if the plants are not permitted to seed.

PLANTING

Except in the far Northwest it is best to plant ginseng seeds in the fall. If they are held until spring, growth may start before they can be planted, in which case many may be lost. Only cracked or germinated seeds should be used. They should be planted 8 inches apart each way in the permanent beds, or 2 by 6 inches in seedbeds and the plants transplanted when 2 years old to stand 8 inches apart. The seeds should be covered 1 inch deep with woods soil or old rotten hickory or basswood sawdust; that from pine or oak trees should not be used. The roots may be set in October or later in the fall so long as the soil is in suitable condition, the crowns being placed about 2 inches below the surface. The most approved distance to plant is 8 inches apart each way, when roots are to be grown until 7 years old in permanent locations.

Many planters round the surface of the beds, making the center several inches higher than the sides, since they find space for more plants on the curved than on the flat surface; but others claim that the possible injury from drought in very convex beds more than offsets this advantage. It is important, however, to have the beds well built up with centers high enough not to retain water after a rain. The paths or alleys should be much lower than the beds, and if they decline from one end to the other they will serve as surface drains during heavy rains. For roots the beds should be worked not more than 6 to 8 inches deep if on ordinary soil. Very heavy soils may be worked more deeply if necessary to obtain better drainage. Seedbeds need not be deeply stirred, as it is not advisable to have them settle to any marked extent.

SHADING

Ginseng grows naturally in rather dense shade, and under cultivation it must be shielded from direct sunlight by some construction that will reduce the light to about one-fourth its normal intensity. When it is planted in open ground this may be accomplished by erecting sheds open on all sides, but covered at the top with lath or boards so spaced as to cut out nearly three-fourths of the sunlight. It is not advisable to use burlap or muslin for shading, as these materials interfere with the free circulation of the air.

There are many methods of constructing shade, but the most common is to set posts firmly in the ground 8 feet apart each way and about 8 feet high above the ground. Scantlings 2 by 4 inches in size are nailed on top of the posts so as to run the long way of the shed. The shade is usually made in sections 4 by 8 feet long, using common 4-foot laths or slats nailed on strips 2 by 2 inches and 8 feet long. The laths should be spaced from one-fourth to one-half inch apart, according to locality, whether in the North or in the South. These sections of shading are laid on top of the 2-by-4 inch runners and so nailed to the posts that the laths run about north and south, thus giving the plants below the benefit of constantly alternating light and shade (fig. 3). Owing to the high cost of lumber, some growers advocate replacing the runners with No. 4 wire, which is run over the tops of the posts and securely fastened thereto.

In the construction of artificial shade it should be borne in mind that free ventilation is very necessary for ginseng. "The higher the

shade the better" is a maxim worth following, as gardens with a free circulation of air are apparently less likely to become diseased.

Seedbeds made under the regulation garden shade are often further protected by a rather low shade to avoid the washing out of the seeds by the drip from the laths. Poultry netting covered with brush, straw, litter, or burlap, made light in spring and denser as the sun gains power, answers very well. In seedbeds made in the open and protected by a low shade alone the seedlings are very apt to damp-off in warm wet weather.

The beds for permanent planting under shade should be 4 feet wide and preferably should run east and west, being so placed that

FIGURE 3.—Lath shed affording partial shade, well suited for growing ginseng, goldenseal, and other woodland plants.

the drip will fall to a great extent in the paths. The sides may be of 12-inch boards set 8 inches or more in the ground to keep out moles and held in place with small stakes.

FERTILIZING

Several weighty arguments may be offered against the excessive use of fertilizers. Heavy feeding tends to lessen the resemblance of the cultivated root to the wild product and consequently reduces its value, as the root most closely resembling the wild in appearance and texture is now in strongest demand. Overfeeding also forces growth and thereby renders the plant less resistant to the attacks of disease. Lime and wood ashes have been used by many growers on their ginseng beds, but either root rust or fiber rot has almost invariably followed their use. If lime is used at all it is well to apply it at least a year before planting. Serious leaf injury has

followed the excessive use of nitrogenous fertilizers, and heavy applications of barnyard manure have also caused severe injury. Experienced growers are now recommending a good rich soil to start with and very moderate forcing.

The very best fertilizers are woods soil or rotted leaves 4 to 6 inches deep, well spaded in to a depth of about 8 inches, and fine raw bonemeal well worked in, applied at the rate of 1 pound to each square yard. If barnyard manures are used they should be very thoroughly rotted, and in order to give the best results they should be worked in some months previous to planting the beds. Some practical growers advise against the use of animal manures or even a soil to which they have been heavily applied. Chemical fertilizers and wood ashes have been used, but as very injurious results have sometimes followed, it is best, for the beginner at least, to depend on hardwood leafmold, old rotted hardwood sawdust, and raw ground bone to enrich the soil.

CULTIVATING

Ginseng requires little if any cultivation, but grass and weeds should be kept out of the beds, and the surface of the soil should be scratched with a light tool whenever it shows signs of caking. Ordinarily one active man can easily care for about 2 acres of ginseng.

MULCHING

In accordance with natural conditions, a winter mulch over the crowns is essential, especially in northern localities. Seedling beds particularly require careful mulching to prevent heaving by frost.

Forest leaves held in place with poultry netting, light brush, or sawdust are best, but cornstalks stripped of the husks, bean vines, cowpea hay, buckwheat straw, or other coarse litter not containing weed seeds or material attractive to mice will answer the purpose. The mulch should not be placed in position until actual freezing weather is imminent, and it should be removed in the spring before the first shoots come through the soil.

A mulch of 4 or 5 inches of leaves or their equivalent in litter is ample for the severest climate, and less is needed in the South. A light summer mulch of sawdust helps keep down weeds and prevents excessive loss of moisture in dry weather.

DRAINAGE

In laying out ginseng beds provision must be made for efficient drainage. The preferable location is on ground that has a gentle slope, but as natural drainage cannot be depended on always to remove excess water from beds, some type of underground drain must be employed. Very satisfactory results have been obtained by the use of clay or cement drain tile in ginseng beds. A line of tiles should be placed under the center of each bed. The proper depth of the drain will vary with the character of the soil, and the size of the tiles will depend on the amount of rainfall. In general, if 3-inch tiles are used the drains should be placed 6 to 8 feet apart and 1½ to 2 feet deep in clay and 3 to 4 feet deep in sand or gravel.

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FOREST PLANTINGS

The earlier successes with ginseng culture were made with plantings in hardwood forests, and this method is still preferred by many growers when a suitable location is available. However, the yield from forest plantings is said to be about one-half that obtained under artificial shade, but on the other hand there is a large saving in the expense for labor and the cost of shading. Growers on the Pacific coast have found that ginseng cannot be grown successfully under tree shade in that region.

In forest plantings the beds should be placed where the shade is continuous and fairly dense. The shade should be produced by tall, open-headed, hardwood trees rather than by undergrowth, to insure free circulation of air. Some experienced growers prefer to plant on land that slopes to the north, thereby providing good drainage, without which ginseng will not thrive, and the coolest location during the heat of the summer. The soil should be deeply plowed or spaded and all tree roots removed. The growth of these roots into the beds should be prevented by occasionally cutting around them with a sharp spade. A liberal quantity of leafmold or well-decayed litter should be worked into the soil, and an application of bonemeal raked into the surface will in most cases be a desirable addition. Ginseng may be planted closer under forest conditions than in garden culture, but in either case the closer the plants stand the greater is the danger from disease. The culture of forest beds is in all respects similar to that of beds under artificial shade, and the winter mulch should in no case be omitted.

PROTECTION

Owing to the comparatively high cost of ginseng plants and roots, the beds should be well protected by fences from the intrusion of wild or domestic animals and should also be carefully guarded against theft, which is not uncommon with this high-priced product. Protection is especially needed with forest plantings, which should always be well enclosed. Moles may be controlled with suitable traps,[2] of which several kinds are on the market. Mice often cause great damage to ginseng, but they may be kept from the beds by wire netting of sufficiently close mesh set 12 to 18 inches in the ground.

DIGGING AND DRYING THE ROOT

The cured root is valued by the Chinese largely according to its size and maturity. The best qualities at proper age break with a somewhat soft and waxy fracture. Young roots dry hard and glassy and are regarded as less desirable. Very small young roots and root fibers often realize less than a dollar a pound, whereas those of the proper size and quality sell readily at top quotations. Undersized or stunted roots if of suitable age are readily salable. Cultivated roots as a rule attain greater size than wild ones of the same age, but on account of their more rapid growth they are harder and denser than the wild roots, and if harvested before they are about 5 years old they will lack in flavor and quality.

Beds should rarely be dug for market until about the sixth year and should then be taken up solidly. The replanting of the under-

[2] See U. S. Department of Agriculture Farmers' Bulletin 1716, Mole Control.

sized or stunted roots is of doubtful value, since they frequently make little more growth. Good roots should run nearly 4 inches long and half an inch in thickness below the crown and should average about an ounce in weight in the fresh state.

Roots may be dug at any time after growth ceases in September, but mid-October is regarded as the most favorable time. They should be carefully washed or shaken free of all adhering soil, but not scraped or scrubbed, as it is important to preserve the natural dusky color of the skin with its characteristic annular markings.

The older roots possess the most substance and when properly cured realize the highest prices. In recent years a demand for ground ginseng has established a market for young roots, which are preferred for milling on account of their hard, flinty texture.

Drying is best effected in a well-ventilated room heated by a stove or a furnace. It has long been customary to start drying between 60° and 80° F. and after a few days to increase the temperature to about 90°, but some experienced growers now recommend that drying start between 100° and 110° and as soon as the roots are wilted that the temperature be reduced to about 90°.

The roots are spread thinly on lattice trays or shelves made of wire netting and are frequently examined and turned, but must always be handled carefully to avoid breaking the forks or marring the surface. Roots measuring more than 2 inches in diameter will need to be dried for about 6 weeks, but smaller roots may be properly dried in less time. In all stages of curing, especially in noticeably damp weather, particular care should be taken to see that the root does not mold or sour, as any defect will greatly depress the selling price. On the other hand, overheating should be avoided, as it tends to discolor the surface and spoil the texture of the interior. Once well cured, the roots should be stored in a dry and airy place, secure from vermin, until ready for sale.

DISEASES [3]

Cultivated ginseng is frequently subject to severe attacks of a number of diseases, the development of which appears to be especially favored by crowding of the plants, excess water in the soil, and lack of proper ventilation.

In their natural state the plants as a rule are thinly scattered on the forest floor under advantageous conditions of ventilation and soil drainage, the normal action of tree roots playing no inconsiderable part in the latter condition, and diseases are likely to remain local in effect. Under the crowded conditions of commercial culture, however, the diseases tend to spread and may cause material injury. Errors in fertilization and soil treatment are also frequent causes of injury and by weakening the resistance of the plants may further invite the inroads of disease.

ALTERNARIA BLIGHT AND ROOT ROT [4]

Alternaria blight is one of the most widespread ginseng diseases and affects both leaves and roots. During the spring the stems of diseased

[3] Condensation of Farmers' Bulletin 736, Ginseng Diseases and Their Control, prepared by S. P. Doolittle, senior pathologist, Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry.
[4] *Alternaria panax* Whetzel.

plants show dark-brown cankers just above the ground line, which enlarge and become covered with a velvety brown coating of the spores (microscopic seedlike bodies) of the fungus causing the disease. Later in the season, large, watersoaked spots develop on the leaves and eventually become papery and dry with a darker, yellow-brown margin (fig. 4).

Later the leaflets may droop where the leafstalk rises at the top of the stem, and brown spore masses may form again at this point. Seed heads are affected, and when such infection occurs the berries often shell. When roots are attacked they rot very slowly, and there is no odor. The lesions are dark brown or black, and the rotted roots

FIGURE 4.—Leaves of ginseng affected with alternaria blight.

remain firm. Root infection apparently occurs only in roots that have been injured.

The spores of the fungus are distributed by the wind and may be carried on clothing from diseased to healthy beds. During moist weather the spores that have lodged on the plants germinate and produce further infection. Because the fungus also lives over winter on diseased leaves and stems of the previous season, it is important that diseased tops be removed and destroyed. After the tops die down the beds also should be disinfected by being soaked down to a depth of an inch with a solution of 1 pound of copper sulfate to 7 gallons of water. The most effective means of control, however, consists in spraying the plants during the growing season with a 3–3–50 bordeaux mixture to which 2 pounds of calcium arsenate have been added (fig. 5). The first application should be made when the

majority of the plants have broken through the soil, the second when the leaflets are fully spread, the third just before blossoming, and the fourth after the fruits are set.

Bordeaux mixture can be purchased in paste and powder form and such preparations are often convenient for use in small plantings. It is somewhat more effective when freshly prepared, however, and can be made more cheaply at home by the following formula: Dissolve 3 pounds of copper sulfate in hot water, using a wooden or earthenware vessel, and dilute to 25 gallons with water. Slake 3 pounds of stone lime (or 5 pounds of hydrated lime) in a small amount of water and dilute to 25 gallons. Pour the two solutions together while stirring and add 2 pounds of calcium arsenate. When only small quantities of the spray are needed, it may be prepared by using 3 ounces of copper

FIGURE 5.—Sprayed and unsprayed ginseng plants attacked by alternaria blight. Except that one was sprayed, both beds received the same treatment.

sulfate and 3 ounces of stone lime or 5 ounces of hydrated lime to a total of 3 gallons of water and adding 2 ounces of calcium arsenate.

PHYTOPHTHORA MILDEW AND ROOT ROT [5]

Phytophthora mildew and soft rot is a fungus disease that affects leaves, stems, and roots of plants of all ages and frequently is very destructive. The leaflets at the top of the diseased plants often droop at the base of the petiole in much the same manner as in alternaria blight and the stems become hollow and discolored. The leaf blades also show spots that in their earlier stages resemble those of alternaria but, although the centers become white, the margins remain a dark, water-soaked green and do not show the yellow-brown border characteristic of alternaria spots (fig. 6). Infected roots develop a soft rot and eventually are invaded by other fungi and bacteria which produce a disagreeable odor.

[5] *Phytophthora cactorum* (Cohn. and Leb.) Schröter

This fungus overwinters in the tissues of diseased plants in the soil and spring infection occurs either in roots or stem, but in either case both roots and tops eventually may become diseased.

The most effective control for the disease consists in spraying with bordeaux mixture as for alternaria blight. To prevent the fungus from passing down the stem to the roots, all wilting or drooping tops should be cut off at the crown and removed. Affected roots should also be removed and destroyed, and the bed disinfected with a solution of 1 pound of copper sulfate in 7 gallons of water. Beds that are infested with this fungus should not be used for a number of years, but if for any reason infested beds must be used, they should be sterilized with steam [6] or with a solution of 1 part of formaldehyde to 50 gallons of water. In using formaldehyde, all roots are first removed and the ground loosely spaded. The solution is then applied at the rate of ½ to 1 gallon per square foot in sufficient quantity to thoroughly saturate the soil. As soon as it can be worked, the soil should then be spaded over to allow the formaldehyde to evaporate. This stirring of the soil should be repeated at intervals for at least 2 weeks before any planting is done, as formaldehyde fumes are injurious to growing plants.

FIGURE 6.—Leaf-spot of phytophthora mildew on ginseng.

ACROSTALAGMUS WILT [7]

Acrostalagmus wilt is a disease of older plants and rarely causes severe damage. It is due to a fungus that penetrates the water-conducting vessels of the root and causes a gradual wilting of the top. Diseased roots seem healthy externally, but when cut across show a yellow zone in the conducting tissue. Diseased roots should be dug and dried to remove the source of infection, and beds where the disease has occurred should be disinfected with formaldehyde or steam.

RAMULARIA ROOT ROT [8]

Ramularia root rot or "rust" is due to a fungus that may attack the roots of plants of all ages but is commonest on seedlings, which often

[6] See Farmers' Bulletin 1629, Steam Sterilization of Soil for Tobacco and Other Crops.
[7] *Acrostalagmus* sp.
[8] *Ramularia* sp.

are rendered worthless. On older roots the spots are a rusty brown but do not penetrate deeply. In seedlings the fine rootlets are damaged and the taproot may become short and knoblike. The disease is favored by an alkaline soil and where it occurs the use of lime or wood ashes should be avoided.

SCLEROTINIA ROTS

There are two ginseng diseases caused by fungi of the genus *Sclerotinia*. One, sclerotinia white rot,[9] occurs in most sections where ginseng is grown but rarely causes widespread damage. It also affects many vegetable crops, and this probably explains its presence in beds on soil where such crops have previously been grown. The disease affects the roots and stem but does not spot the foliage. The diseased stems lose their green color and become hollow. Infected roots rot rapidly, and the tissues are soft and brittle but without bad odor. Within the stem and on the outside of the root, hard, black bodies are formed, sometimes one-quarter of an inch long, which are known as sclerotia. These are the resting bodies of the fungus and remain in the soil over winter. In the spring they produce small cuplike bodies containing spores, which serve as sources of new infection. Good drainage and aeration will do much to prevent losses from the disease. Infected plants should be removed and burned and the soil from which they came disinfected with a copper sulfate solution as described for phytophthora mildew (p. 12).

The other disease of this group, sclerotinia black rot,[10] probably occurs on wild ginseng and also affects the plant known as false solomonseal.[11] It is probably often introduced through forest soil used in making up ginseng beds. It attacks only the roots, making little progress during the growing season. Its presence is indicated by failure of certain plants to come up in the spring, and on digging only black, mummylike roots will be found. Sclerotia are formed on these roots as in the case of white rot, and all roots in the diseased area should be removed and the soil disinfected as previously described (p. 12).

DAMPING-OFF OF SEEDLINGS

Damping-off of seedlings is characterized by a decay of the stem at the surface of the soil, which results in a falling over and death of the affected plants. The disease may be caused by a number of fungi which are commonly present in the soil and whose attacks are favored by excessive moisture and lack of aeration. Good drainage is therefore essential in raising seedlings. Sprinkling sand on the surface of the bed to a depth of one-eighth to one-fourth of an inch is also sometimes of value in checking damping-off. When planted in drills the soil should be kept stirred, particularly after rains. If seedbeds can be sterilized with formaldehyde (p. 12) before planting, losses from damping-off usually can be greatly reduced. Red oxide of copper has recently been widely used to control damping-off of vegetable seedlings. It is applied as a dust and the seed is shaken in a closed container with sufficient dust to thoroughly coat the seed. The excess dust is then screened off and the seed planted. The information available, how-

[9] *Sclerotinia sclerotiorum* (Lib.) Massee.
[10] *Sclerotinia smilacina* Dur. = *S. panacis* Rankin.
[11] *Smilacina racemosa* (L.) Desf.

ever, does not warrant a statement as to its effect on ginseng seed and, if it is used, a small sample of seed should first be dusted and tested to determine whether the treatment affects seed germination.

ROOT KNOT[12]

Root knot, a serious disease affecting nearly 1,500 different plants, is found on ginseng roots in many regions. It is caused by a nematode or eelworm,[13] that lives in galls on the underground parts of the plants (fig. 7). Galls start as very slight swellings but may reach a diameter of one-half inch or more. By careful examination the shiny, white, pear-shaped female nematodes, usually much smaller than a pinhead, can be found in the galls with the unaided eye. This disease destroys ginseng seedlings; it reduces the market value of mature roots, and also makes them unfit for propagation.

FIGURE 7.—Ginseng roots showing nematode galls.

The eradication of root knot from the soil is very difficult. It is best accomplished by running steam[14] through lines of 3- or 4-inch tiles buried 18 to 22 inches apart and 15 to 18 inches deep or through perforated pipes laid temporarily. If drainage is required in the ginseng bed an adaptation of the tiles for double service should be considered. A temperature of 135° F. should be maintained throughout the soil for half an hour. Drenching it with large quantities of boiling water is a possible alternative, provided that the soil deeper than any roots have grown is heated to the above temperature. Pan steaming, formerly recommended, does not kill nematodes to a sufficient depth. No chemical treatment of soil has yet proved 100-percent effective.

To avoid losses from this disease, it is essential to start ginseng plantings in nematode-free land, using absolutely healthy roots or seed that has not been in contact with infested soil. Drainage water from

[12] Revision of this section prepared by Jocelyn Tyler, junior nematologist, Division of Nematology, Bureau of Plant Industry.
[13] *Heterodera marioni* (Cornu) Goodey.
[14] See footnote 6.

an infested area must not flow onto the new beds. Implements must be cleaned and thoroughly dried so as not to introduce any contaminated soil. Fertilizers and mulching materials must come from nematode-free sources.

YIELD AND VALUE OF THE CROP

The yield of cultivated ginseng varies greatly and depends largely on the suitability of the conditions under which the crop is grown and on the skill and experience of the grower. It has been estimated that the roots from a bed measuring 4 by 16 feet, if dug when 6 years old, should weigh about 10 pounds when dry. Yields of dry root from well-managed plantings appear to be at the rate of a ton to the acre, although much larger yields are frequently reported.

Ginseng has long been valued by the Chinese for medicinal use, though rarely credited with curative virtues by other peoples. The dried roots have been exported from the United States in increasing quantities since the early years of the eighteenth century, the prices rising as the wild supply diminished from about 40 cents a pound in the early years of its collection to $24 a pound for the best qualities during 1927. Since then the price has declined greatly.

The cultivation of native ginseng, stimulated by its increasing scarcity and the rising prices, began in an experimental way about 1886, and for a time developed slowly. It is estimated that in 1901 a little less than 20 acres of ginseng were under cultivation in the United States, and, of the root produced, but a small quantity went into the market. In recent years the industry has attained such proportions that the output of cultivated roots appears to be considerably greater than that collected from the forests.

When cultivated ginseng first appeared on the market it sold at prices considerably higher than those paid for the wild root, but about 1904 the price declined to a figure less than that commanded by wild ginseng, and since that time it has for the most part remained at a lower level. The preference in the Chinese markets for wild ginseng over the American cultivated root appears responsible for the difference in the prices offered for wild and cultivated ginseng in the markets of the United States.

A negligible quantity of ginseng is consumed by Chinese residents of North America, and a trifle has been used by manufacturers of domestic medicine, leaving practically the sole outlet for ginseng with the Koreans and Asiatic Chinese. The domestic prices, exports, and valuation of American ginseng from 1914 to 1938, inclusive, are shown in table 1.

THE OUTLOOK FOR THE INDUSTRY

The future success of cultivated ginseng in North America will be determined to a great extent by the attitude of the growers. If the lessons taught by the experience of the preceding 25 years are heeded, the mistakes of the past need not be repeated, and many obstacles that have heretofore hampered the progress of the industry can be removed.

TABLE 1.—*Domestic prices, exports, and value of American ginseng from 1914 to 1938, inclusive*

Year	Domestic prices (per pound) [1]				Exports [2]		
	Wild root		Cultivated root		Quantity	Total value	Average value per pound
	High	Low	High	Low			
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Pounds*	*Dollars*	*Dollars*
1914	11.50	6.00	8.00	3.00	224,605	1,832,686	8.15
1915	9.50	4.50	7.00	2.00	103,184	919,931	8.91
1916	11.00	5.00	6.50	3.00	256,082	1,597,508	6.23
1917	14.00	6.00	7.00	2.50	198,480	1,386,203	6.98
1918	19.00	9.50	9.00	3.00	259,892	1,717,548	6.60
1919	23.00	13.00	12.50	3.00	282,043	2,057,260	7.29
1920	23.00	10.00	12.00	3.00	160,050	1,875,348	11.71
1921	12.00	6.50	8.00	1.00	181,758	1,507,077	8.29
1922	16.00	7.00	12.00	2.00	202,722	2,334,993	11.51
1923	18.00	12.00	15.00	3.00	148,385	2,245,258	15.13
1924	16.50	11.00	14.00	2.00	167,318	2,399,926	14.35
1925	15.00	7.50	13.00	2.00	138,131	1,668,221	12.07
1926	19.00	10.00	13.00	3.00	180,262	2,640,488	14.65
1927	24.00	12.50	13.00	4.00	169,000	2,556,000	15.12
1928	20.00	10.00	12.00	3.50	184,000	2,288,000	12.43
1929	18.50	10.00	12.00	2.00	234,000	2,766,000	11.82
1930	15.50	6.00	11.00	2.00	203,000	1,877,000	9.24
1931	12.00	5.00	9.00	2.00	265,000	1,922,000	7.25
1932	10.00	5.00	7.00	.75	171,000	835,000	4.88
1933	7.00	4.00	4.00	.50	233,000	844,000	3.62
1934	12.50	6.00	3.00	.25	232,000	1,203,000	5.23
1935	7.00	6.00	4.00	2.00	167,000	618,000	3.70
1936	7.00	6.00	4.00	2.00	295,000	1,236,000	4.19
1937	7.00	6.00	11.00	2.00	136,000	706,000	5.18
1938	7.00	6.00	11.00	10.00	167,000	1,028,000	6.15

[1] Prices for 1914 to 1931 were compiled from Hunter-Trader-Trapper, prices for 1932 to 1934 from Special Crops, and those from 1935 to 1938 from Oil, Paint and Drug Reporter.
[2] From annual reports of Foreign Commerce and Navigation of the United States.

The industry still suffers from the disrepute into which it was brought through exaggerated claims made by some dealers in seeds and nursery stock with regard to the possibilities for unusually large profits in the growing of ginseng. Although ginseng is a comparatively unimportant product in this country, it has a place among minor crops of recognized value. For every dollar's worth of ginseng exported in 1938 there were produced in this country about $45 worth of peanuts, $15 worth of onions, $30 worth of strawberries, $3 worth of asparagus, and $5 worth of cranberries.

In comparison with that of other crops, the market for ginseng is small; consequently the industry affords an opportunity for only a limited number of persons without danger of becoming overcrowded. Because yields of the dry root from well-managed plantings appear to be at the rate of a ton to the acre, only a little more than 100 acres of mature ginseng could very readily supply 210,000 pounds of roots, which is the average exportation for the last 10 years. This would represent total plantings of nearly 600 acres, as it requires at least 6 years to grow marketable roots from seed.

The Chinese market formerly absorbed ginseng in quantities considerably in excess of the average exportations for the two decades just past. As shown in table 2, the number of pounds exported during the last 10 years is less than half of the exports for the 10 years 1860–69, and the average price per pound for the 10 years 1929–38 is nearly seven times as great as it was some 70 years ago.

TABLE 2.—*Exports and value of American ginseng for the periods indicated, from 1860 to 1938, inclusive*

Period	Quantity	Value	Average value per pound	Period	Quantity	Value	Average value per pound
	Pounds	*Dollars*	*Dollars*		*Pounds*	*Dollars*	*Dollars*
1860-69	4, 149, 445	3, 902, 209	0. 94	1900-1909	1, 513, 558	9, 610, 614	6. 34
1870-79	4, 041, 727	4, 537, 008	1. 12	1910-19	2, 047, 800	14, 823, 781	7. 24
1880-89	3, 457, 294	6, 771, 830	1. 95	1920-29	1, 764, 800	22, 280, 000	12. 63
1890-99	2, 163, 302	7, 843, 888	3. 62	1930-38	1, 869, 000	9, 634, 000	5. 15

As shown in table 1, the annual exports of ginseng root vary considerably from year to year without any pronounced trend with respect to quantity, but the market value of the root has declined more or less steadily since 1927, when it was $15 a pound. This decline may be due to two causes, overproduction and a change in the proportion of cultivated and wild roots in the supply available for export. About 10 years ago there was quite an increase in the number of ginseng gardens, although accurate statistics indicating the change in the total acreage under cultivation and the number of growers in the last decade are not available. It is believed, however, that some overproduction may have occurred. The supply of wild ginseng is declining yearly, and, since the wild root is generally of higher market value than that from cultivated plants, a smaller proportion of the former in the exports would reduce the average value per pound.

The evident preference of the Chinese for the wild root and the unsatisfactory state of the general market for cultivated ginseng have caused grave doubts as to the future prospects of the industry. These doubts will probably be realized unless growers give more attention to the production of the type of root desired by the Chinese trade. In the future, growers should strive for quality of product and not for quantity of production, as has been the all too common practice in the past. There is always a ready sale for the cultivated roots which closely resemble the wild in quality and conditions, and prudent growers will not fail to adopt the wild root as the standard of future production. The elimination of the poorer grades of cultivated American ginseng, which are now found in the markets, would tend to insure more uniform prices for the root and to lessen the danger of depressing the market through overproduction.

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How To Cultivate Botanical Drugs*

What the Experiments of the United States Government Have Shown.

By Dr, W, W, STOCKBERGER, Bureau of Plant Industry, Washington, D, C,

THE possibility of cultivating crude drugs in this country had become an absorbing topic during the years preceding the outbreak of the European war and since that time more or less agitation on the subject has been featured in popular newspaper and magazine articles. The subject was a romantic one. It appealed to the lay mind. The growing scarcity of certain drugs was noted. Suggestions for supplying the deficiency were made. Hope was expressed that the farmer would devote some of his acreage to this new line. Alluring accounts were written of the ease with which this and that plant could be grown, lists were published containing the names of a vast number of drugs. Those for which there is but little demand were featured with equal prominence with the relatively small number which can be considered as universal staples.

Hot houses at Arlington, Va., where U. S. Government investigators are experimenting in growing botanical drugs.

There is no doubt that the agitation which has been carried on during recent years has awakened a lively interest in the subject of drug growing. Most of the interest, however, has been of a passive kind. As already noted the subject was romantic. It made excellent dinner conversation and was discussed at length at the clubs. Few people, however, really know enough about the subject to discuss it intelligently and almost none appreciated its complexities. You often heard people ask whether aspirin grew on a bush and how drugs could be grown in this country when it was understood that the Germans had them all patented.

In the first place, is there need for a drug raising industry in the United States and its possessions? A study of the market conditions affecting our native drugs indicates that for some species it is high time some action was taken looking toward the prevention of their complete extermination and to provide for a steady supply of those which are growing scarce and for which there is a well developed demand. Respecting imported drugs, the conditions vary from year to year, but it has become more and more apparent that we cannot depend on our foreign friends to supply us uniform drugs of good quality and while the Food and Drugs Act has improved the quality of supplies which enter our markets from abroad, their dependability is uncertain. The sudden cessation of imports due to the European war and the consequent scarcity of many varieties of drugs have demonstrated the dependence of our trade upon foreign sources for its supplies. These conditions sufficiently answer in the affirmative the question asked at the beginning of this paragraph. Another and extremely important reason for the establishment of this industry is in line with the general preparedness which is being launched in this country. We are likely soon to be placed on the defensive by outside military forces and then as never before will our people need medicines and only those will be available which are made from drugs grown within our own orders.

Now that it seems to be generally admitted that there is a genuine need for a drug growing industry in this country, what means are to be adopted for carrying out the project and what branch of industry is best fitted to handle it? Much of the material which has been published on the subject is misleading and the idea that the ordinary farmer can successfully grow drug plants and produce a marketable article is ridiculous. The business of growing drug plants is unlike that of raising and marketing vegetables, and of the hundreds of botanical drugs used in medicine, a few only can be cultivated as a commercial proposition. It can be asserted in the beginning that if the ordinary farmer should undertake the growing of drug plants, it would result in failure to him and discredit the propaganda which has been advanced by those who have seriously investigated the subject. It will be apparent from the subsequent remarks that the only hope of the future success of this industry lies in the establishment of an enterprise having for its sole object the propagation of staple drugs.

A thorough knowledge of the general situation is an essential precursor to the embarkation into the cultivation of drug plants. It is important to know the drugs for which there is a large and steady demand under normal conditions and the price changes which have occurred during the preceding ten years or more. The rise and fall of the price of a grown commodity will indicate the general tendency of the price which can be expected to obtain, though this is, of course, dependent on unusual conditions which may have resulted in a given year such as crop shortage, export tax, embargo, etc. It is important to understand the commercial details in handling drugs, the relations of the crude drugs dealer to the manufacturer who compounds the drugs into medicines, the methods employed by the drug buyers of the manufacturing firms in their dealings with the seller of crude drugs, the forms of contracts between the dealer in crude drugs and the consumer of the commodities, and the modes of payment. It is important to know the approximate quantity of a drug consumed and it is of especial importance to recognize the difference between the healthy, steady demand in good quantity of one drug, and the acute and unusual demand of another. This knowledge can only be acquired from an intimate acquaintance with the wholesale, retail and manufacturing drug trade. It is not described in books. It can be determined only by practical experience which may require many years of application.

What Steps Shoud be Taken

With the possession of an accurate understanding of the commercial features of the drug business and the selec-

* Paper read before Washington Branch of the American Pharmaceutical Association.

tion of a carefully investigated list of drugs, what steps should be taken to produce these commodities on a pay- drug trade. It is not described in books. It can be de- ing basis? Remember now that the romantic period has passed. It is proposed to supply certain commodities for which there is a commercial demand. It must be done with prfiot and dividends are really the criterion on which rests the success or failure of the movement. The fluctuating conditions in the market render it essential that an enterprise devoted to the cultivation of crude drugs should adopt varieties which, in the aggregate, can be depended upon to yield a profit upon the investment. Having determined on a list of desirable plants, the next step concerns itself with a study of the life history of each individual, its favorite habitat, its adaptability if necessary to a changed habitat, the kind and quality of the soil in which it flourishes, the diseases to which it is susceptible and the insect pests to which it may be a prey. Much valuable information relating to these matters has been collected and disseminated by the Office of Poisonous Plant Investigation of the Bureau of Plant Industry, United States Department of Agriculture. The published results of the investigations and the reports of Drs. True and Stockberger and their co-workers furnish authoritative data on many drug plants which can be studied with much profit. This book knowledge should accompany an intimate practical acquaintance with the plants grown in their native habitat or under similar artificial conditions.

An Investment of $50,000 Necessary

After becoming familiar with the natural preferences and idiosyncracies of the individuals, the next important problem is the obtaining of the planting stock with which to start the enterprise and this immediately brings up the question of the amount of acreage needed and simultaneously with question of acreage comes the question of returns. The problem of acreage is crucial and an appreciation of its importance at this point will be apparent when one stops to consider the question. The sale of the drugs raised must yield a reasonable and attractive profit on the investment. Now, in order to embark on an enterprise of this kind, an investment of from $25,000 to $35,000 must be made, exclusive of the land and farm buildings, and when the latter are figured in the investment, the capital may be safely fixed at a minimum of $50,000. In order to realize ten per cent, which is a conservative profit, though not the rosy-fortune profits painted by the enthusiastic romanticists, it is readily seen that from 25 to 50 acres must be put under cultivation, depending somewhat on whether the crops will net, after paying all costs, $100 to $200 per acre, and if they yield less, the acreage must be increased or the enterprise will not carry itself. How many crops will net $200? The reader approaching this subject for the first time will say that the investment is over-estimated, but if anything it is conservative as will be apparent as this subject develops. To return now to the question of source of material for the planting stock with which to sow 25 or 50 acres. If the plants selected have been those which can be grown to advantage in the temperate zone and their selection has been made with due regard to their marketable possibilities, the plantings of root drugs can be obtained from reliable nurseries scattered through the East and Middle West and the seeds of some of the herbaceous plants from responsible seed houses in this country and abroad, or from the experiment stations and farms and from the wild state. But do not imagine that the full acreage can be reached in one year. The planting stock of one acre of hydrastis costs $1,500 and the greenhouse space required for five acres of belladonna will call for an investment of from $2,500 to $5,000. To put it plainly, it is necessary to begin with what can be obtained in the way of seeds and what can be allotted in the way of space and capital, and then work up the acreage from this source. This, of course, defers the dividends, but it is a condition which cannot be altered.

Equipment Similar to Modern Truck Farm

Much of the equipment required to conduct a successful enterprise of this nature is the same as that employed on a modern truck farm. A greenhouse with hot beds and cold frames is essential, an irrigation system of some form is important for the nursery stock of young plants which are later to be transferred to the field, a drying and still house must be constructed and a chemical laboratory must be maintained. The laboratory is indespensably essential. Knowledge of the development of the crop must be maintained in order that the harvest may be gathered at the proper time, the marketed product properly labeled, and its potency known so that controversies over sales may be avoided, seed selection tests properly checked and soil analysis performed to provide for a proper use of fertilizers.

The selection of an efficient personnel to conduct the field work demands serious consideration. The superintendent must be a man competent to handle labor with the least amount of friction commensurate with efficient results, he must be a practical agriculturalist, a competent greenhouse man and capable of developing healthy strains of plants by proper seed selection. He should be the type of man who will work in harmony with the general manager of the enterprise and he should be able to appreciate his own limitations especially with reference to the commercial side of the undertaking. Careful attention must be given to the labor problem and the efficient and economical apportionment of work, as the overhead expenses will average from $500 to $600 per month and it is essential that the returns justify the expenditure.

The responsibility of the propagation of the field crops rests with the superintendent. With an adequate equipment represented by the investment heretofore mentioned, there should be no excuse for failure to produce the last ounce of material that can possibly be raised. Each crop must be harvested at the time when it will yield a product acceptable to the demands of the consuming trade. No two crops will mature at the same time. The co-operation of the laboratory and the advice of the business manager are all important and must be considered by the field working department. The importance of harvesting a crop of commercial value cannot be over estimated. It is easy to gather plants and cure them in a way which will cause the least interference with the general routine of farming operations, but this will seldom yield a product which is acceptable to the trade. The consumers of drugs are particular and it will take years of education to bring about the acceptance of innovations. An enterprise catering to the industry must needs study the demands and endeavor to supply them with satisfaction.

To bring about these conditions necessitates complete co-operation between the farm superintendent, the laboratory and the business manager. Complete records of all operations and charges against each should be kept by the farm superintendent so that after the harvest, the exact cost of each crop may be determined. Future operations will depend largely on this data, but the policy to be adopted with respect to an individual crop will be regulated in accordance with general market conditions and perhaps unusual conditions obtaining during a certain season. For instance, belladonna is a perennial plant, and harvest of the aerial plant may be gathered off one planting for several years. However, it may happen that a scarcity of root in the market will force the price to such a figure that it would be policy to crop both the aerial plant and the root in order to take advantage of the attractive market. Conditions of similar nature will arise continually, and the importance of an understanding of the commercial features which were noted in the beginning will be apparent.

The Question of Marketing

The disposition of a crop of drug plants can be handled to advantage only by one who is familiar with the details of the buying and selling of these commodities. A novice, attempting to market a crop of any drug, no matter how great the demand may be, is doomed to have his cherished hopes of fancied prices dashed to earth. The handlers and consumers of drugs are efficiently organized and the buying proposition has been reduced to a science. The success of a buyer of a commercial house depends upon his ability to save his firm money. He saves money by making purchases at the lowest figures the seller will agree to. The seller who has been in the game for years is cognizant of this condition and the buyer knows what the seller knows, so between the two a mutual respect obtains and an established firm selling drugs can usually

sell his wares at a figure which represents the value of the transaction and which will net a reasonable profit. A novice is at a disadvantage and when he approaches a drug buyer, he will be offered prices, which, if he has kept his proper records, he will find barely cover the cost of operations and in no way correspond with the figures quoted in the trade journals. Unless he is in a position to hold his crop, he will dispose of it at ridiculous prices, thereby temporarily upsetting the market, and as a result quit the game in disgust.

The development of the commercial side of the drug growing enterprise will depend somewhat on the attitude and co-operation of the consumer. Unless the consumer becomes favorably disposed towards the establishment of this industry and by his support encourage the grower to expand and develop, it is a foregone conclusion that the grower will enter the field hitherto occupied by the manufacturer. The manufacturer buys belladonna and digitalis to make into belladonna extract, atropine, digitalis preparations and digitalis glucosides. Unless the grower can obtain prices for his crude drugs that will net him a fair profit on the investment, he will embark in the manufacturing field and develop a line of high grade products and specialties. His opportunity for this development is unsurpassed and by his control of the crude material he will soon prove a dangerous competitor. For instance, if the consumer refuses to pay a fair price for belladonna as it is now grown containing three times the alkaloidal content of the ordinary commercial article, it will be but a simple matter for the grower to convert all of his crop into solid extract of belladonna and from one pound of drug obtain three times as much extract as the manufacturer who is using the imported supplies. Then he can through his selling agency approach the trade consuming this commodity and compete most advantageously. He can do the same with digitalis; he can make his own digitalin, his own atropine and the active and potent principles of many other staples. In fact, this may well be the logical development of the industry in this country.

Chemistry of Botanicals in its Infancy

The grower of botanical drugs will be obliged to face the antagonism of agitators opposed to the use of these commodities. There is a well intrenched school of thought in this country which ridicules the use of botanical drugs by the medical profession. But it is absurd to say that, because a drug has never been shown to have any definite chemical individual in its composition to which therapeutic activity can be attributed, it is valueless for the treatment of dsease. The fact that no potent principle has been reported is no proof that none exists. The chemistry of botanical drugs is in its infancy. Systematic physiological experimentation has not even begun. Medical science is the least exact of any and the empirical tests of practitioners over many years attest to the therapeutic importance of drugs which are often ridiculed by others. Many of these drugs are recognized in the pharmacopoeias of the world, standards which have been adopted by the laws of the land. Careful research would undoubtedly isolate the principles on which the therapeutic activity depends. But the fact that no principle has as yet been isolated is no reason for condemning the drug. Furthermore, the beneficial effect of a mixed preparation is not due to any one component, but to the combined influence of the several ingredients in the blend.

One of the most difficult features of establishing an enterprise of this kind is that of financing. The banks in this country look with disfavor on any new line of industry and while they will rush in pell mell to loan money on questionable railroading and mining schemes, a solicitation to advance money with which to float a drug growing enterprise would be turned down before the story was half told. In this respect the German system is far in advance of anything we have in this country. There, if an individual or a group of men desire to launch a new industry, a technical agent or representative of the bankers confers with solicitors, and if the enterprise has any merit at all, he recommends the advance of the money and the business starts. New lines of endeavor are fostered in Germany. They are frowned upon in this country.

Capitalists Apt to Have Wrong Views

In the United States the only way an enterprise of this kind can be launched is through the patronage of wealthy patriotic men. Unfortunately even this source of capital is misled into believing that drug plats can be grown on country estates and by tenant farmers and we read of experiments being performed with plots of digitalis, viburnum, opulus, etc. This is not the kind of help such people should render. There is data enough available about how to grow different drugs. These high minded gentlemen can do their country far greater service by backing in a tangible way a carefully organized company and one that is thoroughly familiar with all sides of the situation.

On the whole, a complicated and difficult situation confronts those who would embark in the propagation of drug plants. It is not a situation with which the ordinary agriculturist can cope. The difficulties can be surmounted only by an enterprise backed with adequate capital and controlled by those possessing an expert knowledge of the peculiarities of the plants, the demands of the trade and the ways and means of coping with commercial details.

Students of pharmacy of University of Minnesota observing botanical drug specimens. *(See story on next page)*

UNITED STATES DEPARTMENT OF AGRICULTURE, BUREAU OF PLANT INDUSTRY.
Office of Drug and Related Plant Investigations

A List of Medicinal Plants
grown in drug gardens of Schools or Pharmacy and other Institutions
in the United States during the years 1927 to 1929

Compiled by the Office of Drug and Related Plants, 1930

EXPLANATION OF SYMBOLS

The numerals following the name of a species indicate the gardens in which it has been grown. (See list below.)

+ signifies that growth and development were normal.
- signifies abnormal growth or failure.
a signifies species grown in the greenhouse.

LIST OF MEDICINAL PLANT GARDENS

The name of each garden is followed by the name and address of the officer in charge.

1. Garden of Medicinal Plants of the College of Pharmacy,
Dr. C.W. Johnson, Director,
University of Washington, Seattle, Wash.

2. Medicinal Plant Garden of the College of Pharmacy,
Dr. David H. Boot, Director,
University of Iowa, Iowa City, Iowa.

3. Medicinal Plant Garden of the St. Louis College of Pharmacy, and
St. Louis Botanical Garden,
Dr. George T.Moore, Director,
Missouri Botanical Gardens, St. Louis, Mo.

4. Drug Garden of the University of Florida,
Dr. B.V.Christensen, Director,
University of Florida, Gainesville, Fla.

5. Medicinal Plant Garden of the School of Pharmacy,
Dr. F.J.Bacon, Director,
Western Reserve University, Cleveland, Ohio.

6. Medicinal Plant Garden of the School of Pharmacy,
Prof. C.E. Mollett, Director,
Montana State University, Missoula, Mont.

7. Medicinal Plant Garden of the School of Pharmacy,
Prof. Chalmers J. Zufall, Director, Purdue
University, Lafayette, Ind.

8. Wisconsin Pharmaceutical Garden,
Dr. Edward Kremers, Director,
University of Wisconsin, Madison, Wis.

9. Medicinal Plant Garden of the College of Pharmacy,
Dr. Frederick J. Wulling, Director,
University of Minnesota, Minneapolis, Minn.

10. Medicinal Plant Garden of the State College of Washington,
Prof. P.H. Durstine, Director,
State College of Washington, Pullman, Wash.

11. Drug Garden of the School of Pharmacy,
Prof. Loyd E. Harris, Director,
University of Oklahoma, Norman, Okla.

12. Medicinal Plant Garden of the University of Buffalo,
Prof. A.B. Lemon, Director,
University of Buffalo, Buffalo, N.Y.

13. Medicinal Plant Garden of the College of Pharmacy,
Prof. Rufus A. Lyman, Director,
University of Nebraska, Lincoln, Nebr.

14. Medicinal Plant Garden of St. Peters Hospital, and the
private Medicinal Plant Garden of Dr. F.B. Kilmer,
Dr. F.B. Kilmer,
New Brunswick, N.J.

15. Medicinal Plant Garden, South Dakota State College,
Dr. Karl H. Rang, Director,
Division of Pharmacy, South Dakota State College, Brookings, S.D.

16. Experimental Drug Garden of the Philadelphia College of Pharmacy
and Science,
Dr. Arno Viehover and Mr. Thomas S. Githens in Charge,
Philadelphia College of Pharmacy and Science, Philadelphia, Pa.,
(Viehover), or Glenolden, Pa. (Githens).

17. U.S. Department of Agriculture Drug Plant Garden,
A.F. Sievers, in Charge,
Drug and Related Plants, Bureau of Plant Industry,
U.S.Department of Agriculture, Washington, D.C.

LIST OF SPECIES GROWN

Note:

The United States Dispensatory, 21st edition, is authority for the plant names as given in this list.

The names underscored are synonyms given in Britton and Brown's Illustrated Flora (2d edition), Gray's New Manual, or Bailey's Standard Cyclopedia of Horticulture.

Names marked with an asterisk are not found in the last three editions of the U.S. Dispensatory but belong to genera that include medicinal species.

The supplementary List consists of plant names that are not found in the last three editions of the U.S. Dispensatory and that do not belong to genera furnishing medicinal species, but which were grown in the gardens indicated. Names in this list marked with an asterisk have not been found in botanical lists or manuals that are usually consulted.

Abrus precatorius 3+ 9- 16-
Acacia arabica 9+a 16-
*Acacia dealbata 9+a
Achillea millefolium 1+ 2+ 3+ 4+ 6+ 8+ 9+ 14- 16+
*<u>Aconitum californicum</u> = (A. columbianum)
*Aconitum columbianum 16+
Aconitum fischeri 1+ 3- 9- 14+ 16+
*Aconitum lutescens 3- 6+ 14+
Aconitum lycoctonum 3- 9+ 16-
Aconitum napellus 2+ 3- 5+ 3- 9- 10- 13+ 14+ 16+
Aconitum paniculatum 3- 14- 16+
Aconitum uncinatum 1+ 3- 16-
*<u>Aconitum wilsonii</u> -(A.fischeri)
Acorus calamus 1+ 2+ 3+ 6+ 8+ 13+ 14+ 15+ 16+ 17+
Actaea alba 1+ 3+ 9+ 16+ 17+
Actaea rubra 1+ 2+ 3+ 9+ 16-
Adiantum pedatum 9+
Adonis aestivalis 9+
Adonis autumnalis 9+
Adonis vernalis 1= 2+ 3+ 8- 9+ 16-
Agave americana 1+ 2+ 3+ 9+a
Agrimonia eupatoria 1+ 2+ 16+ (See footnote)
<u>Agrimonia officinalis</u> = (A. eupatoria)
Agropyron repens 1+ 2+ 8+ 9+ 16+
Ailanthus glandulosa 1+ 3+ 16+
Ajuga reptans 1+ 14+ 16-

<u>Footnote:</u> - The Old World <u>Agrimonia eupatoria</u> is not an American species. See the American species, Agrimonia gryposepala and A. striata, in Britton and Brown's illustrated Flora and Gray's New Manual.

Aloe vera 9+a
Aletris farinosa 9-
Alkanna tinctoria 3+ 14+
Allium sativum 1+ 2+ 3+ 6+ 8+ 9+ 14+
*Allium schoenoprasum 1+ 3+
Aloe ferox 9+a
Aloe perryi 9+a
Alpinia officinarum 8- 14+
Althaea officinalis 1+ 2+ 3+ 4+ 6+ 7+ 8+ 9+ 10+ 12+ 13+ 14+ 16+ 17+
Althaea rosea 1+ 2+ 3+ 4+ 9+ 14+ 16+
*Alnus mollis = (A. alnobetula, A. viridis) 2+
Amaranthus sp. 1+ 2+ 3+ 9+ 16+
Ampelopsis quinquefolia =(Psedera quinquefolia, Parthenocissus quinquefolia)
1+ 2+ 3+ 5+ 8+ 9+ 14+ 16+
Amygdalus communis = (Prunus communis) 1+ 9+a
Amygdalus persica = (Prunus persica)
Anacyclus pyrethrum 1+ 3+ 10-
Andropogon squarrosa - (Vetiveria zizanioides)
Anemone pratensis = (Pulsatilla pratensis)
Anemone pulsatilla = (Pulsatilla vulgaria)
Anethum graveolens = (Peucedanum graveolens)
Angelica archangelica - (A. officinalis, Archangelica officinalis) 1+ 3+ 9+ 14+ 15+ 16+
Angelica atropurpurea 1+ 3+ 9+
Angelica officinalis = (A. archangelica)
Anthemis arvensis 1+ 3+ 17+
Anthemis cotula 2+ 3+ 9+ 16+
Anthemis nobilis 1+ 2- 3+ 8+ 9+ 14+ 16+
Anthemis tinctoria 1+ 3+ 9+ 14+ 16+
Apium graveolens 1+ 2+ 3+ 8+ 9+ 12+ 15+ 16+
Apocynum androsaemifolium 16-
Apocynum cannabinum 1+ 2+ 3+ 5+ 9+ 14- 15+ 16+
Aquilegia canadensis 1+ 3+ 9+
*Aquilegia vulgaris 1+ 2- 3+ 14+
Arachis hypogea 2+
Aralia nudicaulis 1+ 2+ 9+ 16+
Aralia racemosa 1+ 3+ 5+ 7+ 8+ 9+ 12+ 14+ 16+ 17+
Archangelica officinalis = (Angelica archangelica)
Arctium lappa 1+ 5+ 7+ 8+ 9+ 10+ 14+ 16+
Arctium minus 2+ 3+ 5+
Arctostaphylos uva-ursi 1+ 2- 16-
Areca catechu 9+a
Argemone mexicana 16+
Arisaema triphyllum 1+ 2+ 3+ 7+ 8+ 9+ 16+ 17+
Aristolochia hastata 16+
Aristolochia reticulata 3+ 9+
Aristolochia serpentaria 1+ 3+ 9- 14- 16-
*Arnica cordifolia 3+
Arnica montana 1+ 2· 3- 6+ 9- 14-
Artemisia absinthium 1+ 2+ 3+ 6+ 8+ 9+ 10+ 12+ 14+ 15+ 16+
*Artemisia annua 3+ 8+ 9+ 16+
*Artemisia argentea 17+
Artemisia cina 8- 9- 14+ 16+ 17-
Artemisia dracunculus 1+ 3+ 8- 9+ 14+

Artemisia frigida 1+ 3+ 6+ 8+ 16+
Artemisia gnaphalodes 4+ 16+ 17+
Artemisia vulgaris 1+ 3+ 9+ 14+ 16+ 17+
Arum maculatum 1+ 3- 7+
Asagrea officinalis = (Schoenocaulon officinalis)
Asarum canadense 1+ 3+ 7+ 8+ 9+ 12+ 16+
*Asarum caudatum 1+
Asclepias incarnata 2+ 16+
Asclepias syriaca 2+ 9+
Asclepias tuberosa 1+ 2+ 3+ 6+ 7+ 9+ 14+ 16-
Asimina triloba 9-
Asparagus officinalis 1+ 2+ 3+ 8+ 9+ 14+ 16+
Asperula odorata 1+ 3+
Aspidium marginale = (Dryopteris marginalis)
Astragalus baeticus 1+
Atropa belladonna 1+ 2+ 3+ 4+ 5+ 7+ 8+ 9+ 10+ 11+ 12+ 13+ 14+ 15+ 16+ 17+
Avena sativa 3+ 6+ 8+ 9+ 16+
*Baptisia australis 17-
Baptisia tinctoria 1+ 2- 3+ 8- 14+ 16+
Barosma betulina 8- 9- 15+
*Berberis aquifolium 1+ 3+ 6+ 9- 10+ 16+
*Berberis nervosa 1+
*Berberis thunbergii 1+ 3+ 8+ 9+ 16+
Berberis vulgaris 1+ 8+ 9+ 14+ 16+
Bertholletia excelsa 2+
Beta vulgaris 5+ 8+ 14+
Betula lenta 1+ 6+ 8+ 16+
Bocconia cordata 1+ 3+ 9+ 14+
Borago officinalis 1+ 2+ 3+ 9+ 16+
Brassica alba = (Sinapis alba)
Brassica campestris 16+
Brassica campestris rapa - (Sinapis campestris rapa) 16+
Brassica juncea = (Sinapis juncea) 3+ 4+ 16+
Brassica napus dichotoma 16+
Brassica nigra = (Sinapis nigra) 1+ 2+ 3+ 4+ 5+ 6+ 7+ 8+ 9+ 12+ 14+ 15+ 16+
Brauneria angustifolia = (Echinacea angustifolia) 1+ 3+ 9+ 17+
Brauneria pallida = (Echinacea pallida) 3+ 8- 9+
Brauneria purpurea = (Echinacea purpurea) 1+ 3+ 8- 9+
Bryonia alba 1+ 3+ 9+ 14-
Bryonia dioica 1+ 3+ 9+ 14- 15-
Buxus sempervirens 16+
Cactus grandiflorus = (Cereus grandiflorus, Selenicereus grandiflorus) 1+ 3+ 4+/9+a
Caesalpinia tinctoria = (Coulteria chilensis) 16+
Calendula officinalis 1+ 2+ 3+ 4+ 6+ 7+ 8+ 9+ 10+ 11+ 12+ 13+ 14+ 15+ 16+ 17+
Canna edulis 2+
Cannabis indica = (C. sativa)
Cannabis sativa 1+ 2+ 3+ 4+ 5+ 6+ 7+ 8+ 9+ 10+ 14- 15+ 16+
Cannabis sativa (form gigantea) 3+ 9+ 14+ 15+ 16+
Capsicum annuum 2+ 3+ 9+ 16+
Capsicum fastigiatum 2- 3+ 8+ 15+
Capsicum frutescens 1+ 2+ 3+ 4+ 8+ 9+ 15+ 16+
Carica papaya 3+ 9+
Carthamus tinctorius 1+ 2+ 3+ 6+ 8+ 9+ 11+ 15+ 16+ 17-
Carum ajowan 8+ 14+
Carum carvi 1+ 2+ 4+ 5+ 6+ 7+ 8+ 9+ 11+ 12+ 15+ 16+ 17+

Cassia acutifolia 8-
Cassia angustifolia 1+ 2+ 8-
*Cassia artemisioides 1+ 2+
Cassia fistula 8- 9+
Cassia marilandica 2- 3+ 9+ 16+
*Castalia mexicana = (Nymphaea mexicana) 1+
Castanea dentata 1+ 6+ 9+
Caulophyllum thalictroides 1+ 3+ 7+ 9+ 12+ 16+
Ceanothus americanus 1+ 3+ 6+ 9+ 16+ 8+
Celastrus scandens 1+ 3+ 8+ 9+ 12+ 14+ 16+
*Centaurea cyanus 1+ 9+ 16+ 17+
*Cephalanthus occidentalis 9+ 16+
Cercis canadensis 1+ 3+
Cereus grandiflorus = (Cactus grandiflorus)
Chamaelirium luteum 1+ 6+ 9+ 17+
Chelidonium majus 1+ 3+ 8+ 9+ 14+ 16+ 17+
Chelone glabra 1+ 8- 9+ 16- 17+
Chenopodium ambrosioides 1+ 2+ 5+ 6+ 9+ 10- 15+ 16+
Chenopodium anthelminticum 1+ 2+ 3+ 4+ 6+ 7+ 8+ 12+ 14+ 15+ 16+ 17+
Chimaphila maculata 1+
Chimaphila umbellata 1+ 6+ 16-
Chionanthus virginica 3+ 9+ 16+
Chlorogalum pomeridianum 17+
Chrozophora tinctorius = (Croton tinctorius)
Chrysanthemum cinerariaefolium 1+ 2+ 3+ 4+ 5+ 7+ 8+ 9+ 15- 16+ 17+
Chrysanthemum leucanthemum 1+ 3+ 9+ 15+ 16-
Chrysanthemum roseum = (Pyrethrum roseum) 3+ 7+ 9+
Cichorium intybus 1+ 2+ 3+ 7+ 8+ 9+ 12+ 14+ 16+
Cicuta maculata 2+ 3+ 6+ 9+ 15+ 16+
*Cimcifuga americana 1+
Cimcifuga racemosa 1+ 3+ 7- 9+ 12+ 14+ 16+
Cinchona calisaya 16+
Cineraria maritima = (Senecio cineraria) 1+ 9+
Cinnamomum camphora 1+ 3+ 4+ 9+a 15+a
Cinnamomum cassia 1+ 9+
Citrullus colocynthis 1+ 2- 4+ 8+ 9+ 16+
Citrus aurantium 1+ 3+ 4+ 8+ 9+ 16+
Citrus medica 3+ 8+ 9+
Claviceps purpurea 8+ 16+
Cnicus benedictus 2- 3+ 4+ 8+ 9+
Cochlearia armoracia = (Armoracia armoracia, Radicula armoracia, Roripa armoracia) 1+ 3+ 9+
Cochlearia officinalis 1+ 3+
Cocos nucifera 2-
Coffea arabica 3+
Coix lachryma-jobi 1+ 3+ 9+ 15+ 16+
Colchicum autumnale 1+ 2+ 3- 8- 17+
Conium maculatum 1+ 2+ 3+ 4+ 6+ 8+ 9+ 14+ 15+ 16+
Convallaria majalis 1+ 3+ 5+ 6+ 7+ 8+ 9+ 12+ 14- 16+ 17+
Convolvulus scammonia 9+
Coptis trifolia 6+ 9+ 14- 16-
Coriandrum sativum 1+ 2+ 3+ 5+ 6+ 7+ 8+ 9+ 11+ 14+ 15+ 16+ 17-
Collinsonia canadensis 1+ 5+ 9+ 16+ 17-

Cornus florida 1+ 3+ 4+ 9+ 16+
*Corylus americana 1+ 9+ 16+
Corylus avollana 2-
Coulteria chilensis = (Caesalpinia tinctoria)
Crataegus oxycantha 1+ 8+ 9+ 16+
Crocus sativus 1+ 9+ 14+ 16+ 17+
*Croton tinctorius = (Chrozophora tinctorius) 9-
Curcubita pepo 2+ 4+ 6+ 8+ 9+ 14+ 16+
Cuminum cyminum 3+ 8- 16-
Cydonia oblonga = (Pyrus cydonia)
Cydonia vulgaris = (Pyrus cydonia)
Cynoglossum officinale 16+
*Cypripedium candidum 9+
Cypripedium hirsutum = (C. pubescens, C. reginae)
Cypripedium parviflorum 3+ 7+ 8+ 9+ 16-
Cypripedium pubescens = (C. hirsutum) 1+ 9+ 14- 16-
Cypripedium reginae = (C. spectabile, C. hirsutum) 3+ 9+
Cytisus scoparius 1+ 8- 9+a 16+
Daphne mezereum 1+ 3+ 12+
Datura alba flava 9+ 14-
Datura arborea 3+ 9+a
*Datura ceratocaula 8+
*Datura chlorantha = (D. humilis flava)
Datura fastuosa 3+ 6+ 8+ 9+ 14+ 15+
Datura fastuosa alba 3+ 8+ 9+ 15+
Datura ferox 3+ 8+ 9+ 15+
*Datura humilis flava = (D. chlorantha) 3+ 8+ 9+ 15+
*Datura hybrida 8+ 14+
*Datura inermis 8+
*Datura inoxia 11+ 17+
*Datura laevis 8+ 9+
*Datura leichardti 8+
Datura meteloides 2- 3+ 8+ 9+ 15+ 16+ 17+
*Datura quercifolia 8-
Datura stramonium 1+ 2+ 3+ 4+ 5+ 6- 7+ 8+ 9+ 10+ 11+ 12+ 13+ 14+ 15+ 16+ 17+
*Datura tatula 1+ 2+ 3+ 5+ 7+ 8+ 9+ 14+ 15+ 16+
*Datura wrightii 7+ 8+ 9+
*Datura wrightii hybrida 8+
Delphinium ajacis 1- 3+ 5+ 8+ 9+ 16+
Delphinium consolida 1- 2+ 3+ 4+ 5+ 6+ 7+ 8+ 9+ 14+ 16-
Delphinium exaltatum 16-
*Delphinium formosum 16+
Delphinium staphisagria 1+ 2- 3+ 8- 14+ 16-
*Delphinium tricorne 16-
*Digitalis ambigua 2+ 3+ 15+ 16+ 17+
*Digitalis ferruginea 3+ 9+ 15+ 16+
*Digitalis gloxinia 9+ 15+ 16+
*Digitalis gloxinioides 3+ 16+
*Digitalis lanata 3+ 9+ 14+ 15+ 16+
*Digitalis maculata 1+ 16+
*Digitalis lutea 3+ 5+ 8+ 9+ 15+ 16+
Digitalis purpurea 1+ 2+ 3+ 4- 5+ 6+ 7+ 8+ 9+ 10+ 11+ 12+ 13+ 14+ 15+ 16+ 17+
Digitalis purpurea monstrosa 3+ 15+ 16+
Digitablis sibirica 1+ 2+ 3+ 15+ 17+

Dioscorea villosa 1+ 2+ 3+ 4+ 9+ 15+ 16+ 17+
Diospyros virginiana 16+
Dracaena draco 9+a
Drosera rotundifolia 1+ 3+ 9+
Dryopteris filix-mas = (Aspidium filix-mas) 1+ 2+ 3+ 9+ 14+ 16+
Dryopteris marginalis - (Aspidium marginale) 1+ 3+ 7+ 8+ 9+ 16+
Ecballium elaterium 1+ 3+
Echinacea = (Brauneria)
Elettaria cardamomum 2- 8- 9+a 16-
Epilobium angustifolium 1+
Equisetum hyemale 2+ 3+ 16+
Erigeron canadensis 1+ 2+ 3+ 8+ 9+ 16+
Eriodictyon californicum 2+ 9+
Erythraea centaurium = (Centaurium umbellatum, Gentiana centaurium) 1+ 3+ 16+
Eschscholtzia californica 1+ 2+ 3+ 5+ 8+ 9+ 16+
Eucalyptus globulus 1- 2+ 3+ 9+ 16+
*Eucalyptus resinifera 9+
Eucalyptus rostrata 9+
Euonymus alatus 16+
Euonymus americanus 16+
Euonymus atropurpureus 1+ 2+ 3+ 9+ 14+ 16+
Euonymus europaeus 1+ 16+
*Eupatorium maculatum 2+
Eupatorium perfoliatum 1+ 3+ 5+ 7+ 8+ 9+ 14+ 16+
*Eupatorium purpureum 1+ 3+ 8+ 9+ 16+
*Eupatorium urticaefolium 3+ 5+ 13+ 16+
Euphorbia lathyrus 17+
Euphorbia pilulifera 1+ 6+ 9-
Ferula foetida 9-
Ficus carica 1+ 9+a 16+
Ficus elastica 1+ 2+ 3+ 9+a
Foeniculum vulgare 1+ 2+ 3+ 4+ 5+ 6+ 7+ 8+ 9+ 11+ 16+ 17+
Fraxinus americanus 8+ 16+
Fraxinus ornus 1+ 3- 9+
Galega officinalis 1+ 3+ 8+ 9- 16+
Gaultheria procumbens 1+ 2- 3- 8+ 9- 12+ 14+ 17+
Gelsemium sempervirens 4+ 9+a 12+ 16+
Genista tinctoria 1+ 8- 16+
*Gentiana andrewsii 1+ 9+
Gentiana centaurium = (Erythraea centaurium)
Gentiana lutea 3- 14+
Geranium maculatum 1+ 2+ 3+ 7+ 8+ 9+ 14+ 16+ 17+
Geum canadense 16+
Gillenia trifoliata 1+ 3+ 9- 16+
Glycine hispida 2+
Glycyrrhiza glabra 1+ 3+ 9-
Glycyrrhiza lepitoda 16+ 17-
*Gossypium arboreum 3+ 4+
Gossypium herbaceum 1- 2+ 3+ 5- 6+ 9+ 14+ 16+
Gossypium hirsutum 15-
Grindelia robusta 1+ 6+ 7+ 9+ 15+
Grindolia squarrosa 1+ 2+ 3+ 8+ 15+ 16+
Guizotia abyssinica = (G. oleifera)
Guizotia oleifera 17+

Hamamelis virginiana 1+ 2- 3+ 6- 8- 9- 12+ 14+ 16+
Hedeoma pulegioides 1+ 2+ 3+ 6+ 9+ 15+ 16+ 17+
Helianthemum canadense 3+ 9+ 14-
Helianthus annuus 2+ 3+ 4+ 5+ 6+ 8+ 9+ 16+ 17+
Helianthus tuberosus 1+ 3+ 9+
Helleborus niger 1+ 3+ 9+ 14- 15+ 16+
Heuchera americana 1+ 3+ 6+ 9+ 16+
*Heuchera sanguinea 1+ 3+ 9+
*Hibiscus africanus =(H. trionum)
Hibiscus trionum 14+
Hordeum distichon 16+
Hordeum vulgare 5+ 6+ 8+ 9+ 16+
Humulus lupulus 1+ 2+ 3+ 5+ 6+ 7+ 8+ 9+ 12+ 13+ 14+ 16+
Hydrangea arborescens 1+ 3+ 16+
Hydrastis canadensis 1+ 2+ 3+ 7+ 8+ 9+ 14- 15+ 16+ 17-
Hyoscyamus albus 1+ 3+ 15+
Hyoscyamus muticus 3+ 14-
Hyoscyamus niger 1+ 2+ 3+ 4+ 6+ 7+ 8+ 9+ 10+ 12+ 14+ 15+ 16+ 17+
Hyoscyamus pictus = (H.niger)
Hypericum perforatum 1+ 3+ 14+ 16+
Hyssopus officinalis 1+ 3+ 9+ 16+
Ilex cassine 16+
Ilex opaca 3+ 7+a
Illicium anisatum = (L. parviflorum)
Illicium parviflorum 1+ 9-
Inula helenium 1+ 3+ 4+ 5+ 8+ 9+ 14+ 15+ 16+
Ipomoea quamoclit 9+
*Iris cristata 1+
Iris florentina 1+ 3+ 6+ 7+ 8+ 9+ 10+ 15+ 16+ 17+
Iris germanica 1+ 2+ 3+ 5+ 7+ 8+ 9+ 14+ 15+ 16+ 17+
*Iris japonica 1+ 14- 16+
Iris pallida 1+ 3+ 8+ 9+
Iris pseudacorus 1+ 9+
Iris versicolor 1+ 2+ 3+ 4+ 6+ 7+ 8+ 9+ 10+ 11+ 12+ 13+ 14+ 15+ 16+
Isatis tinctoria 2+ 3+ 6+ 15+ 16+
Jasminum grandiflorum 17+
*Jasminum officinale 3+
Jatropha curcas 2+ 16-
Juglans cineria 1+ 2+ 6+ 8+ 9+
Juglans nigra 1+ 2+ 9+ 16+
Juglans regia 2+
Juniperus communis 1+ 3+ 4+ 6+ 8- 9+ 13+ 14+ 15- 16+
Juniperus sabina 1+ 6+ 9+ 12+ 13+
Juniperus virgiana 1+ 3+ 4+ 8+ 9+ 16+
Larix europaea = (L. decidua, L. larix) 8+ 14+
Laurus nobilis 1+ 9+
Lavandula latifolia = (L. spica) 1+ 3+ 4+ 8- 9+ 10+ 12+ 14+ 16+ 17+
Lavandula spica vera = (L. vera) 1+ 2- 3+ 4+ 8- 9+ 14+ 15- 16+ 17+ 16+
Leontodon taraxacum = (Taraxacum officinalis) 2+ 6+ 7+ 8+ 9+ 10+ 13+ 14+15+/
Leonorus cardiaca 5- 9+
Leptandra virginica 2+ 3+ 9+ 15+
Levisticum officinale 1+ 3+ 8+ 9+ 15+ 16+ 17+
Liatris spicata 1+ 3+ 9+ 14+ 16+
*Ligusticum canadense 1+

Ligusticum filicinum 8-
Lilium tigrinum 1+ 9+ 14+
Linum usitatissimum 1+ 2+ 3+ 4+ 5+ 7+ 8+ 9+ 11- 12+ 14+ 15+ 16+
Liquidambar styraciflua 1+ 3+ 4+ 6- 16+
*Lobelia cardinalis 1+ 2+ 3+ 9+ 14+ 16+
Lobelia inflata 1+ 3+ 8- 9+ 11+ 15+ 16+
*Lobelia syphilitica 1+ 2+ 3+ 9+ 14- 16+
Luffa cylindrica 16+
*Lupinus perennis 1+ 6+ 14+ 16+
Lycopus virginicus 16+
Majorana = (Origanum)
Malus = (Pyrus)
Malva rotundifolia 1+ 2+ 3+ 6+ 8+ 9+ 16+
Malva sylvestris 14+
Marrubium vulgare 1+ 2+ 3+ 4+ 6+ 7+ 8+ 9+ 12+ 14+ 15+ 16+ 17+
Maruta cotula = (Anthemis cotula)
*Matricaria capensis 1+
Matricaria chamomilla 1+ 2+ 3+ 4+ 5+ 6+ 7+ 8+ 9+ 12+ 14+ 15+ 16+
Melaleuca leucadendron 1+ 9+a 15+ 16-
Melia azedarach 1+ 9+a
*Melilotus alba 2+
Melilotus officinalis 1+ 2+ 3+ 4+ 6+ 8- 16+
Melissa officinalis 1+ 3+ 9+ 15+ 16+ 17+
Menispermum canadense 2+ 3+ 9+ 16+
Mentha arvensis 1+ 3+ 5+ 16+
Mentha arvensis canadensis = (M. canadensis)
Mentha arvensis piperascens 3+ 4+ 7+ 8+ 10+ 11+ 17+
Mentha canadensis = (M. arvensis canadensis) 6+ 8+
*Mentha citrata 1+ 3+ 4+ 5+ 7+ 8+ 17+
Mentha crispa 1+ 3+ 8+ 9+
Mentha longifolia 8+ 16+
Mentha piperita 1+ 2+ 3+ 4+ 5+ 6+ 7+ 8+ 9+ 10+ 11+ 12+ 14+ 15+ 16+ 17+
Mentha pulegium 1+ 3+ 8+ 9+
Mentha spicata 1+ 2+ 3+ 4+ 5+ 6+ 7+ 8+ 9+ 10+ 11+ 12+ 13+ 14+ 15+ 16+ 17+
Mentha viridis = (M. spicata)
Menyanthes trifoliata 9+
Mirabilis jalapa 2+ 9+
Monarda didyma 1+ 3+ 4+ 8+ 12+ 16+
Monarda fistulosa 2+ 3+ 4+ 6+ 7+ 8+ 9+ 14+ 16+ 17+
*Monarda mollis 2+ 3+
Monarda punctata 2+ 3+ 4+ 8+ 16-
Morus nigra 1+ 3+ 16+
Myrica caroliniensis 1+ 9-
Myrica cerifera 3+ 4+ 16+
Myrtus communis 1+ 9-
Nasturtium officinale = (Radicula nasturtium-aquaticum)
Nepeta cataria 1+ 2+ 3+ 4+ 6+ 7+ 8+ 9+ 12+ 14+ 15+ 16+ 17+
Nerium oleander 1+ 9+a 16+
Nicotiana repanda 9+
*Nicotiana sanguinea 14-
Nicotiana tabacum 1+ 2+ 3+ 6+ 8+ 9+ 14+ 15+ 16+
Nigella damascena 9+
Nymphaea mexicana = (Castalia mexicana)

Ocimum basilicum 1- 2+ 3+ 5+ 8+ 9+ 16+ 17+
*Ocimum viridiflorum 17+
*Oenothora lamarckiana 2+ 9+
Olea europea 1+ 3+ 9+a
Origanum majorana 1+ 3+ 8+ 9+ 16+
Origanum officinale = (O. vulgare)
Origanum vulgare 1+ 3+ 8+ 14+
Osmorhiza longistylis = (Washingtonia longistylis) 9+
Oxydendron arboreum 16+
Paeonia officinalis 1+ 2+ 9+ 14+ 15+
Panax quinquefolium 1- 2- 3- 6- 7+ 8+ 9+ 17-
*Papaver californicum 1+ 2+
*Papaver orientalo 1+ 2+ 3+ 14+ 16+
Papaver rhoeas 3+ 9+
Papaver somniferum 1+ 2+ 3+ 4+ 5+ 6+ 7+ 8+ 9+ 14- 15+ 16+
Papaver somniferum var. album 1+ 2+ 3+ 8+ 14-
Parietaria officinalis 17-
Parthenocissus quinquefolia= (Ampelopsis quiquefolia)
*Passiflora edulis 16+
Passiflora incarnata 9+
*Pelargonium graveolens 1+
Pelargonium odoratissimum 8+ 9+ 16+ 17+
Perilla frutescens = (P. ocimoides)
Perilla ocimoides 8+ 17-
Peucedanum graveolens = (Anethum graveolens) 1+ 3+ 8+ 9+ 16+
Phlox ovata 14+
*Phlox paniculata 1+ 14+
Phytolacca decandra 1+ 2+ 3+ 4+ 5+ 6+ 7+ 8+ 9+ 12+ 14+ 15+ 16+
Picea excelsa 1+
Pimpinella anisum 1+ 2+ 3+ 4+ 7+ 8+ 9+ 11+ 15+ 16+ 17+
Pinus strobus 1+ 8+ 9- 16+
Pinus sylvestris 1+ 14+
Piper nigrum 1+ 3- 9+
Plantago psyllium 9+ 17+
Podophyllum emodi 9+
Podophyllum peltatum 1+ 2+ 3+ 5+ 6+ 7+ 8+ 9+ 12+ 13+ 14+ 16+ 17+
Polygala senega 1+ 3+ 9-
*Polygonatum biflorum 1+ 8+ 9+
*Polygonatum commutatum 1+ 2+ 3+ 9+
Polygonatum multiflorum 7+ 8+
Polygonum tinctorium 14+
Polypodium vulgare 1+ 9+
Poplus balsamifera 1+ 3+ 6+
*Populus deltoides 2+
Populus nigra 1+ 9+
Prunella vulgaris 1+ 3+
Prunus avium 2+
Prunus communis = (Amygdalus communis)
Prunus laurocerasus 1+ 3+ 9+
Prunus persica = (Amygdalus persica) 2+
Prunus serotina 1+ 2+ 3+ 4+ 8+ 9+
Prunus spinosa 2+
Prunus virginiana 2+ 16+
Psedera quinquefolia - (Ampelopsis quinquefolia)

Ptelea trifoliata 1+ 3+ 9+ 16+
Pulsatilla pratensis = (Anemone pratensis) 1+ 5+ 9+
Pulsatilla vulgaris - (Anemone pulsatilla) 1+ 14- 16+
Punica granatum 1+ 2+ 3+ 4+ 9+a 16+
*Pycnanthemum albescens 8-
Pycnanthemum flexuosum 3+
Pyrethrum roseum = (Chrysa[illegible])
*Pyrus arnoldia = (Malus arnoldia) 2+
Pyrus cydonia = (Cydonia vulgaris) 1+ 4+ 9+a 16+
Pyrus malus = (Malus malus, M. sylvestris) 2+
Pyrus prunifolia = (Malus prunifolia) 2+
*Pyrus pumila = (Malus pumila) 2+
*Pyrus robusta = (Malus robusta) 2-
Pyrus sylvestris = (Malus sylvestris) 2+
Quercus alba 1+ 2+ 3+ 8+ 9- 16+
Radicula armoracia = (Cochlearia armoracia)
Radicula nasturtium-aquaticum = (Nasturtium officinale, Roripa nasturtium, Sisymbrium nasturtium-aquaticum) 1+ 9+ 14+
*Reseda odorata 1+ 9+
Rhamnus alnifolia 6+
*Rhamnus caroliniana 3+
Rhamnus cathartica 3+ 8- 9+ 16+ 17+
Rhamnus frangula 1+ 3+ 5+ 9- 12+ 17+
Rhamnus purshiana 1+ 2+ 3+ 5+ 6+ 7- 8- 15+ 16+
Rheum officinale 1+ 2+ 3+ 5+ 7- 8+ 9+ 13+ 14+ 15+ 16+
Rheum palmatum 1+ 3+ 9+ 13+ 14+ 15+
Rheum rhaponticum 3+ 6+ 9+
*Rheum tanguticum 3+ 9+ 13+
*Rhus copallina 3+ 16+
Rhus glabra 1+ 2+ 3+ 4+ 6+ 7+ 8+ 9+ 12+ 13+ 14+ 16+
Rhus toxicodendron = (R. rydbergii, Toxicodendron rydbergii) 1+ 2+ 3+ 4+ 7+ 8+ / 16+
Rhus typhina 16+
Ricinus communis 1+ 2+ 3+ 4+ 5+ 6- 7+ 8+ 9+ 11+ 12+ 14+ 15+ 16+ 17+
Ricinus communis cambodgensis 3+ 15+
Ricinus communis sanguineus 2+ 3+ 7+ 9+ 15+ 16+
*Ricinus zanzibarensis 1+ 2+ 3+ 7+ 9+
Robinia pseudo-acacia 16+
Roripa armoracia = (Cochlearia armoracia)
Roripa nasturtium = (Radicula nasturtium-aquaticum)
Rosa canina 1+ 14+
Rosmarinus officinalis 1+ 3+ 6+ 8+ 9+a 14+ 16+
Rubia tinctorium 1+ 17+
*Rubus andrewsianus 1+
Rubus cuneifolius 1+
Rubus ideaus 1+ 3+ 6+ 8+ 9+
Rubus nigrobaccus 3+ 6+ 8+ 9+ 16+
Rubus strigosus 1+ 3+ 8+
Rubus villosus 2+ 3+ 8+ 16+
Ruellia ciliosa 8- 9- 17+
Rumex crispus 1+ 2+ 3+ 5+ 6+ 8+ 9+ 14+ 15+ 16+
Rumex obtusifolius 3+ 5+ 8+ 9+ 16+
*Rumex scutatus 1+
Ruta graveolens 1+ 2+ 3+ 8+ 9+ 14+ 16+ 17+

Salix alba 6+ 9+
*Salix longifolia 2+
*Salix viminalis 2+
Salomonia commutata = (Polygonatum commutatum)
*Salvia azurea 3+
Salvia hispanica 3+ 16- 14- 15+
Salvia horminum 17-
*Salvia nutans 17+
Salvia officinalis 1+ 2+ 3+ 4+ 5+ 6+ 7+ 8+ 9+ 10+ 12+ 13+ 14+ 15- 16+ 17+
Salvia sclarea 17+
Sambucus canadensis 1+ 2+ 3+ 6+ 8+ 9+ 12+ 16+
Sambucus nigra 1+ 4+ 9+
Sanguinaria canadensis 1+ 2+ 3+ 6+ 7+ 8+ 9+ 1[illegible]+ 13+ 14+ 15+ 16+ 17-
Saponaria officinalis 1+ 3+ 8+ 9+ 16+
*Sarracenia purpurea 1+ 9-
Sassafras variifolium 1+ 2+ 3+ 4+ 7+ 9- 16+
Satureia hortensis 3+ 8+ 15+ 16+ 17+
Satureia montana 3+ 8-
Schoenocaulon officinale = (Asagraea officinalis) 3+ 9- 16+
Scopola = (Scopolia)
Scopolia carniolica 3- 14+
Scopolia japonica 14- 17-
Scrophularia leporella 16+
Scrophularia marilandica 16+
Scrophularia nodosa = (S. marilandica)
Scutellaria lateriflora 9- 16+
Secale cereale 6+ 8+ 9+ 16+
Selenicereus grandiflorus = (Cactus grandiflorus)
Senecio aureus 3+ 9+
*Senecio canus 6+
Senecio cineraria = (Cineraria maritima)
Serenoa serrulata 3+ 9+a
Sesamum indicum 1+ 2+ 3+ 4+ 6- 8+ 10+ 17+
Sesamum orientale = (S. indicum)
Silphium laciniatum 3+
*Silphium perfoliatum 3+ 9+
Sinapis alba = (Brassica alba) 1+ 2+ 3+ 4+6+ 7+ 8+ 11+ 12+ 14+ 15+ 16+
Sinapis campestris rapa = (Brassica campestris rapa)
Sinapis juncea = (Brassica juncea)
Sinapis nigra = (Brassica nigra)
Sisymbrium nasturtium-aquaticum = (Radicula nasturtium-aquaticum)
Solanum carolinense 1+ 3+ 16+
Solanum dulcamara 1+ 3- 5+ 6+ 8+ 9+ 12+ 14- 15+ 16+
Solanum nigrum 2+ 3+ 8+ 9+ 14- 16+ 17+
*Solanum sanitwongsei 17+
Solidago odora 1+ 8+ 16+
Spathyema foetida 9+ 16+
Spigelia marilandica 1+ 8+ 9+ 15+ 16+ 17+
Stillingia sylvatica 15+ 16-
Strychnos ignatii 8-
Strychnos nux-vomica 8-
Strychnos toxifera 2- 8-
Symphytum officinale 1+ 3+ 6+ 9? 17+

Tamarindus indica 1+ 3+
Tanacetum vulgare 1+ 2+ 3+ 5+ 6+ 7+ 8+ 9+ 14+ 15+ 16+ 17+
Taraktogenos kurzii 16+
Taraxacum officinale = (Leontodon taraxacum)
*Thalictrum foliolosum 14+
Thea sinensis 1+ 3- 9+
Thuja occidentalis 1+ 3+ 6+ 8+ 9-
Thymus vulgaris 1+ 2- 3+ 6+ 8+ 9+ 14+ 15+ 16+ 17+
Toxicodendron rydbergii = (Rhus toxicodendron)
Trifolium pratense 2+ 3+ 8+ 9+ 16+
Trigonella foenum-graecum 1+ 3+ 8- 16+
*Trillium declinatum 9+
Trillium erectum 1+ 3+ 6+ 7+ 8+ 9+ 14+ 15+ 16+
*Trillium grandiflorum 9+
Triosteum perfoliatum 3+
Tussilago farfara 1+ 3+ 9- 15+ 17+
Ulex europaeus 1+
Ulmus fulva 1+ 2+ 3+ 6+ 9+a 16+
Urginea maritima 1+ 2+ 3+ 8+ 16+
Ustilago maydis 8+ 15+
Valeriana officinalis 1+ 2- 3+ 5+ 7- 8+ 9+ 14+ 15+ 16+ 17+
Vanilla planifolia 3+ 9+a
Veratrum album 3- 9-
Veratrum nigrum 3- 15+
Veratrum viride 1+ 3- 6+ 9+ 16+
*Verbascum blattaria 1+ 3+ 15+ 16+
*Verbascum nigrum 3+ 9+ 15+
Verbascum phlomoides 1+ 9+
Verbascum thapsiforme 1+ 3+ 15+
Verbascum thapsus 1+ 2+ 5+ 8+ 9+ 12+ 15+ 16+
Verbena hastata 1+ 2+ 3+ 9+ 14+ 16+
*Verbena urticifolia 2+ 3+ 16+
Veronica virginica 1+ 2+ 3+ 9+ 14+ 16+
Vetiveria zizanoides = (Andropogon squarrosa) 9+
Viburnum lentago 1+ 2+ 3+ 8+ 9+ 16+
Viburnum opulus 1+ 2+ 3+ 5+ 6+ 7+ 9+ 12+ 16+
*Viburnum opulus americanum 1+ 3+ 8+
Viburnum prunifolium 2+ 3+ 8+ 12+ 16+
*Viburnum rufidulum 3+
Vinca major 1+ 3+ 9+ 14+
Washingtonia longistylis = (Osmorhiza longistylis)
Yucca filamentosa 1+ 3+ 9+ 14-
Zanthoxylum americanum 1+ 2+ 3+ 8+ 9+ 16+
*Zanthoxylum bungei 3+ 17+
Zanthoxylum clava-herculis 3+ 4+
*Zanthoxylum piperitum 16+
Zea mays 2+ 3+ 4+ 5+ 6- 8+ 9+ 15+ 16+
Zingiber officinale 1+ 3+ 4+ 8- 14-
*Zygadenus elegans 3-

UNITED STATES DEPARTMENT OF AGRICULTURE, BUREAU OF PLANT INDUSTRY,
Office of Drug, Poisonous and Oil Plant Investigations.

A LIST OF MEDICINAL PLANTS

GROWN IN SCHOOL OF PHARMACY DRUG GARDENS IN THE UNITED STATES

Compiled by W. W. Stockberger, February, 1923.

EXPLANATION OF SYMBOLS.

The numerals following the name of a species indicate the gardens in which it has been grown (See list below).

+ signifies that growth and development were normal
- signifies abnormal growth or failure
a signifies that the species were grown in 1922
b signifies species grown in the greenhouse.

LIST OF MEDICINAL PLANT GARDENS.

The name of each garden is followed by the name and address of the officer in charge.

1. Medicinal Plant Garden of the College of Pharmacy,
Dr. F. J. Wulling, Director; Dr. E. L. Newcomb, Superintendent,
University Campus, University of Minnesota, Minneapolis, Minn.

2. Wisconsin Pharmaceutical Garden,
Dr. Edward Kremers, Director,
University of Wisconsin, Madison, Wis.

3. Botanical Gardens, Philadelphia College of Pharmacy and Science,
Dr. Heber W. Youngken, Director,
145 North 10th St., Philadelphia, Pa.

4. U. S. Naval Pharmacists' Mates School Medicinal Garden,
Lt. Comdr. George W. Calver (MC) U.S.N.,
Hospital Station, Portsmouth, Va.

5. University of Buffalo College of Pharmacy Drug Garden,
Prof. A. B. Lemon, University of Buffalo, College of Pharmacy,
Buffalo, N. Y.

6. University of North Carolina Drug Garden,
Prof. H. R. Totten,
Chapel Hill, N. C.

7. Queen City College of Pharmacy Drug Garden,
Dr. Caswell A. Mayo,
5th and Pike Sts., Cincinnati, O.

8. Western Reserve University Botanical Garden,
Prof. E. E. Stanford,
2045 Adelbert Road, Cleveland, O.

9. Valparaiso University School of Pharmacy Drug Garden,
Prof. Geo. C. Schicks, Valparaiso, Ind.

10. Pharmacy Department Drug Gardens,
Prof. David H. Boot,
University of Iowa, Iowa City, Iowa.

11. Pharmaceutical Garden, University of Washington,
Dr. C. W. Johnson, Director,
College of Pharmacy, University of Washington,
Seattle, Wash.

12. Purdue Medicinal Plant Garden,
Prof. C. J. Zufall,
Purdue University, Lafayette, Ind.

13. Medicinal and Poisonous Plant Garden,
Dr. S. N. Blackberg, Agr. and Mech. College of Texas,
College Station, Texas.

14. Montana State University School of Pharmacy, Medicinal Plant Garden,
Prof. C. E. Mollett, Missoula, Mont.

15. State College of Washington Drug Garden,
Prof. J. L. Powers, Pullman, Wash.

16. College of Pharmacy, University of Nebraska Drug Garden,
Dr. Rufus A. Lyman, Dean, Lincoln, Neb.

17. The Medicinal and Poisonous Plant Investigations Garden,
Prof. Anton Hogstbad, Jr.
S. D. State College School of Pharmacy,
Brookings, S. D.

18. University of Utah Drug Garden,
Prof. Harry L. Thompson,
University of Utah, Salt Lake City, Utah.

19. Botanical Garden, University of Michigan,
Prof. H. H. Bartlett, Director,
335 Packard St., Ann Arbor, Mich.

20. Arlington Farm Drug Garden,
Dr. W. W. Stockberger,
Drug Plant Investigations, Bureau of Plant Industry,
Department of Agriculture, Washington, D. C.

Abrus precatorius 1-b, 17-
Acacia Farnesiana 20-a
Achillea Millefolium 1+, 2+a, 3+a, 4+a, 6+a,7+, 8+a, 11+a, 14+, [illegible]
Aconitum Fischeri 1+, 3-a, 17-
Aconitum lutescens 20-a
Aconitum Lycoctonum 1+, 3+a
Aconitum Napellus 1+, 2-, 3+a, 4+a, 5+a, 6-, 8+a, 11+a, 14+, 16-, 17-a, 19+, 20-a
Aconitum paniculatum 3+a
Aconitum uncinatum 3-
Aconitum Wilsonii 3+a
Acorus Calamus 1+a, 2+a, 4+a, 5+a, 6+, 8-a, 9+, 11+a, [illegible], 15+, 16+a, 17+a,
19+, 20+a
Actaea alba 7+, 8+a, 17+, 19+a, 20-a
Actaea rubra 1+a, 17+, 20-
Adonis vernalis 1+, 2-, 9+, 16+, 19+a
Aesculus Hippocastanum 1+a
Agave americana 1+, 7-
Agrimonia Eupatoria 3+a, 11+a, 17+
Agrimonia officinalis = A. Eupatoria
Agropyron repens 1+a, 2+a, 4a, 15+, 17+, 19+
Ailanthus glandulosa 8+a, 20+
Aletris farinosa 1-, 3-, 4+a, 17+, 19+a, 20-
Alkanna tinctoria 4+a
Allium sativum 1+, 3+a, 6+a, 9+a, 11+a, 14+
Allium Schoenoprasum 11+a
Aloe ferox 1+a, 3+, 5+a, 16+ab, 19+
Aloe Perryi 1+a, 16+ab
Aloe vera 19+
Alpinia Galangal 1-b
Alpinia officinarum 1+a, 2-
Althaea officinalis 1+a,2+a, 3+a, 4+a, 5+a, 6-a, 8-, 9+a, 10+a, 11+a, 12+a,
13+, 14+, 15+a, 16+a, 17+, 18+a, 19+, 20+a
Althaea rosea 1+a, 6+a, 11+a, 14+
Amaranthus sp. 1+
Ampelopsis quinquefolia 1+a, 2+a, 11+a
Amygdalus communis = Prunus communis
Anacyclus Pyrethrum 1+
Andropogon nardus = Cymbopogon nardus
Andropogon squarrosa = Vetiveria zizanioides
Anemone hepatica = Hepatica triloba
Anemone Pulsatilla 14+, 16+a, 19+
Anethum graveolens 1+a, 2+a, 3+a, 4+a, 5-, 6+a, 8-a, 10+a, 11+a, 12+a, 15+a,
16+, 17+a, 19+, 20+a
Angelica atropurpurea 1+a, 8+a, 20+
Angelica officinalis 11+a, 19+
Anthemis arvensis 1+a, 11+a, 16+
Anthemis Cotula 2+, 3+a
Anthemis nobilis 1+a, 2+a, 3+, 4-a, 11+a, 13+, 19+, 20+a
Anthemis tinctoria 17+, 19+
Anthriscus Cerefolium 7-
Apium graveolens 1+a, 3+a, 5+a, 14+, 15+a, 16+
Apium Petroselinum 1+a, 3+a, 11+a, 14+, 16+
Apocynum cannabinum 1+a, 3+a, 4+a, 7-, 8+a, 11+a, 14+, 16+a, 19+
Aquilegia canadensis 1+a, 4+a, 16+a, 19+

Aquilegia vulgaris 19+
Aralia nudicaulis 6+a, 8-
Aralia racemosa 1+a, 2+a, 3+a, 8+a, 16+, 19-, 20-
Archangelica officinalis 1+a, 11+a, 16+
Arctium Lappa 1+a, 2+a, 3+a, 4+a, 5+a, 6+a, 8+a, 11+a, 12+a, 14+, 15+a,
16+a, 17+a, 18+a, 19+, 20+
Arctium minus 10+a
Arctostaphylos Uva ursi 1-, 6+a, 9+, 11+a, 14+, 16-
Areca Catechu lab
Argemone alba 20+
Arisaema triphyllum 1+a, 2+a, 3+a, 8+a, 9+, 16+, 19+a, 20+a
Aristolochia Serpentaria 1-, 3-, 16-, 19+, 20+
Arnica cordifolia 14+
Arnica montana 1-, 16- , 17-a, 20-
Artemisia Abrotanum 1+a, 4+a, 20+
Artemisia Absinthium 1+a, 2+a, 3+a, 4+a, 5+a, 6+a, 8-, 9+a, 10+a, 11+a, 13-,
14+, 16+a, 17+a, 18+a, 19+, 20+a
Artemisia annua 1+a, 2+a, 3+a, 5-, 6-, 13+, 14+, 16+, 17+a, 18+a, 19+, 20+
Artemisia Cina 20+a
Artemisia Dracunculus 1+a, 2-, 6+a, 11+a, 20-
Artemisia frigida 1+a, 2-, 11+a, 14+, 17+a, 19+, 20+. 6-
Artemisia gnaphalodes 20+a
Artemisia vulgaris 1+a, 6-
Arum maculatum 1-, 4+a
Asarum arifolium 19+a
Asarum canadense 1+a, 2+a, 3+a, 7+, 8-, 12+a, 17+
Asclepias incarnata 1+a, 3+a, 14+, 19+a
Asclepias pulchra 20+
Asclepias tuberosa 1+a, 4+a, 6+a, 7-, 11+a, 14+, 16+a, 17+, 19+, 20+
Asparagus officinalis 1+a, 10+a
Asperula odorata 17+
Aspidium marginale = Dryopteris marginalis
Astragalus bisulcatus 17+
Atropa Belladonna 1+a, 2+a, 3+a, 4+a, 5+a, 6-, 7+, 8+a, 9+a, 10+a, 11+a, 13-,
14+, 15+a, 16+a, 17+a, 18+a, 19+, 20+a
Atropa physalodes = Nicandra physalodes
Avena sativa 1+a, 2+a, 3+a, 14+, 15+
Baptisia tinctoria 1+a, 2-, 4+a, 16+, 20+
Barosma betulina 1-, 2-
Bellis perennis 1+a
Benzoin aestivale 6+a
Berberis aquifolium 1-, 3+a, 8-a, 9+a, 11+a, 14+, 16-
Berberis nervosa 1-, 11+a
Berberis Thunbergii 1+a, 2+a, 3+a, 6+a, 8+a, 20+
Berberis vulgaris 1+a, 2+a, 3+a, 11+a, 14+, 20+
Beta vulgaris 1+, 11+a, 12+a, 14+, 15+, 17+a
Betula alba 2+a
Betula lenta 1-, 11+a, 16+
Bicuculla canadensis 8+
Bicuculla Cucullaria 1+a, 2+a, 8+
Bocconia cordata 1+a, 4+a
Boltonia glastifolia 4+a
Borago officinalis 1+a, 3+a, 6+a, 8-a, 11+a, 16+a, 17+a, 19+, 20+
Brassica alba 20+

Brassica campestris 20+
Brassica napus dichotama 20+
Brassica nigra 20+
Brauneria angustifolia 1+a, 8-, 11+a, 16+a, 19+, 20+
Brauneria pallida 1+a, 2-, 16+a, 19+
Brauneria purpurea 1+a, 2-, 16+, 20+
Bryonia alba 1-, 19+, 20-
Bryonia dioica 17+a, 20-
Cactus grandifloru s 1+a, 5+a
Caesalpinia tinctoria 20+
Calendula officinalis 1+a, 2+a, 3+a, 5+a, 6+a, 7+, 8+a, 9+, 10+a, 11+a, 12+a,
13+, 14+, 15+a, 16+a, 17+a, 19+, 20+a
Cannabis indica 3+a, 4+a, 5+a, 9+a, 12+a, 14+, 15+, 16+a, 17+a, 19+, 20+
Cannabis sativa 1+a, 2+a, 3+a, 4+a, 5+a, 6+a, 10+a, 11+a, 13+, 16+a, 17+a,
19+, 20+
Cannabis sativa (form gigantea) 17-
Capsicum annuum 20+a
Capsicum fastigiatum 1+a, 2+, 10+a, 14-, 16+a, 19+, 20+
Capsicum frutescens 2+, 3+a, 4+a, 5+a, 11+a, 14-, 16+a, 19+
Carica Papaya 4+ab
Carthamus tinctorius 1+a, 2+a, 3+a, 6+a, 8-, 14+, 16+, 17+a, 20+a
Carum ajowan 20+a
Carum copticum 2+a
Carum carvi 1+a, 2+a, 3+a, 4+a, 5+a, 6+a, 8-, 11+a, 12+a, 13+, 14+, 15+a, 16+,
17+a, 18+a, 19+, 20+a
Cassia acutifolia 2-a
Cassia angustifolia 2-, 20-
Cassia artemisioides 17-
Cassia Fistula 1ab
Cassia marilandica 1+a, 11+a, 16+
Castanea dentata 1-, 11+a, 14+
Castilloa elastica 1-b
Caulophyllum thalictroides 1+a, 7+, 8+a, 11+a, 16+, 19+a, 20+
Ceanothus americanus 1+a
Celastrus scandens 1+a, 2+a, 7+, 8+, 11+a, 16+, 19+
Celosia cristata 1+a
Centaurea cyanus 1+a, 3+a
Cephalanthus occidentalis 1+a
Ceratonia Siliqua 1ab, 11+ab
Cereus grandiflorus 19+
Chamaelirium luteu m 1+, 3+a, 6+a, 14+, 19+, 20+a
Chelidonium majus 1+a, 16-a, 17-, 20+
Chelone glabra 1+a, 2-, 7+, 11+a, 19+, 20+a
Chenopodium ambrosioides 3+a, 5+a, 14+, 19+, 20+
Chenopodium anthelminticum 1+a, 2+, 3+a, 4+a, 6+a, 8+a, 10+a, 13+, 14+, 15+,
17+a, 19+, 20+a
Chimaphila maculata 1-, 8-, 16-, 19-
Chimaphila umbellata 1-, 14+
Chionanthus virginica 1+a, 3+a, 6+a, 19+
Chrysanthemum cinerariaefolium 1+, 2+a, 3-, 4+a, 6-, 8-, 11+a, 13-, 17+, 20+a
Chrysanthemum Leucanthemum 20+
Chrysanthemum roseum 1+a, 19+
Cichorium Intybus 1+a, 2+a, 3+a, 4+a, 6+a, 7+, 9+a, 10+a, 11+a, 12+a, 15+a,
17+a, 19+, 20+
Cicuta maculata 1+a, 3+a, 16+, 17+, 19+

Cicuta occidentalis 20+
Cimicifuga americana 19+a
Cimicifuga racemosa 1+a, 3+a, 4+a, 5+a, 6+a, 7+, 11+a, 16+a, 17+a, 19+a, 20+
Cinchóna Calisaya 1-b
Cineraria maritima = Senecio Cineraria
Cinnamomum Camphora 1+b, 4+ab, 11+a, 16+ab, 17+a, 20-
Cinnamomum cassia lab
Citrullus Colocynthis 1+, 2+, 3 +a, 8-, 20-
Citrus Aurantium lab, 11+ab
Citrus medica lab
Claviceps purpurea 2+
Cnicus benedictus 1+a, 2+a
Cochlearia officinalis 1+a, 4+a, 11+a
Coffea arabica 1-b
Coffea Arabica var. Erecta 4+ab
Coffea Arabica var. Murata 4+ab
Coffea Arabica var. Podora 4+ab
Coix Lachryma-Jobi 1+a, 11+a, 16+a, 17+a, 19+
Colchicum autumnale 1+, 2-a, 11+a, 16+a, 17-, 20+a
Collinsonia canadensis 3+a, 7+, 8+a, 19+, 20+a
Conium maculatum 1+a, 2+a, 3+a, 4+, 5+a, 6+a, 7-, 9+a, 11+a, 13+, 14+, 15-,
16+a, 17+a, 19+, 20+
Convallaria majalis 1+a, 2+a, 3+a, 4+a, 5+a, 6+a, 7-, 8+a, .9+a, 11+a, 13-,
14+, 16+a, 17+a, 19+, 20+a
Convolvulus Scammonia 1+a
Coptis trifolia 3+a, 8+a, 14+, 16+, 20-
Coriandrum sativum 1+a, 2+a, 3+a, 4+, 5+a, 6+a, 8+a, 11+a, 12+a, 14+, 15+,
16+a, 17+a, 20+a
Cornus florida 1+a, 4+a, 6+a, 7+, 11+a, 16+
Corylus americana 1+a
Crataegus Oxycantha 1+a
Crocus sativus 1+, 3+a, 6+a, 11+a, 20+a
Crotolaria juncea 20+
Croton tinctorius 1-b
Cucurbita Pepo 11+a
Cuminum Cyminum 2+, 11+a, 17+a
Curcuma longa 1-b
Cydonia oblonga 1+a
Cymbopogon nardus 4+ab
Cypripedium candidum 1+a
Cypripedium hirsutum = C. reginae
Cypripedium parviflorum 1+a, 2+a, 3+a, 14+, 16+a, 17+, 19+
Cypripedium pubescens 1+a, 3+a, 11-a, 17+, 19+
Cypripedium reginae 1+a, 6+a, 11-a, 14+, 17+, 2 0-
Cypripedium spectabile = C. reginae
Cytisus scoparius 1+a,2-a, 3+a, 6+a, 11+a, 17+, 19-, 20+
Daphne Mezéreum 1+, 6-, 19+
Datura alba flava 1+a, 2+
Datura arborea 20+
Datura coerulea flava 1+a,2+
Datura enatocaula 2+
Datura fastuosa 1+a, 2+, 17+, 20+
Datura fastuosa alba 1+a, 2+, 17+a
Datura ferox 1+a, 2+
Datura gigantea 1+a, 2+, 17+
Datura humilis flava 1+a, 2+, 17+a

Datura hybrida 2+
Datura inermis 1+a, 2+, 4+a, 6-, 8+, 15-, 18+a, 20+
Datura innoxia 20+a
Datura laevis 1+a, 2+
Datura leichardti 2+, 20+
Datura metoloides 1+a, 2+, 3+a, 6-, 17+a, 19+, 20+
Datura quercifolia 2+, 20+
Datura Stramonium 1+a, 2+a, 3+a, 4+a, 5+a, 6+a, 7-, 8+a, 9+a, 10+a, 11+a,
12+a, 13+, 14-, 15+a, 16+a, 17+a, 18+a, 19+, 20+a
Datura Tatula 1+a, 2+, 3+a, 8+a, 11+a, 12+a, 15+, 16+a, 17+a, 19+
Datura wrightii 1+a, 2+, 12+a, 19+
Datura wrightii hybrida 2+
Delphinium Ajacis 1+a, 2+a, 3+a, 14+, 17+a
Delphinium Consolida 1+, 5+a, 7-, 8+a, 13+, 15+, 17+a, 20+a
Delphinium formosum 3+a
Delphinium Staphisagria 1-, 2-a, 4-a, 9+a, 10+a, 16-, 17+a
Dictamnus albus 4+a
Digitalis ambigua 1+a, 3+a, 4+a, 6-, 10+a, 11+a, 15-, 19+, 20+a
Digitalis campanulata 20+
Digitalis ferruginea 1+a
Digitalis gloxinia 20+
Digitalis gloxinioides 20+
Digitalis lanata 1+a, 19+
Digitalis lutea 1+a, 16+a, 17+a
Digitalis maculata 1+a, 11+a, 15+, 20+
Digitalis maculata superba 20+
Digitalis purpurea 1+a, 2+a, 3+a, 4+a, 5+a, 6+a, 7+, 8+a, 9-a, 10+a, 11+a,
13+, 14+, 15+a, 16+a, 17+a, 18+a, 19+, 20+a
Digitalis purpurea monstrosa 17+a, 20+
Digitalis sibirica 6-, 11+a, 17+a, 19+, 20+a
Dioscorea villosa 1+a, 3+a, 6+a, 7+, 11+a, 16+
Dracaena Draco lab
Drosera intermedia 1+b, 3+a
Drosera longifolia 1+b
Drosera rotundifolia 1+b, 3+a, 8-, 14+
Dryopteris Filix-mas 1+a, 6-, 11+a, 14+, 16+a, 17+
Dryopteris marginalis 1+a, 2+a, 3+a, 6+a, 8+a, 11+a, 16-, 20-
Ecballium Elaterium 1+a, 20+
Echinacea angustifolia = Brauneria angustifolia
Elettaria Cardamomum lab, 4+ab
Epilobium angustifolium 19+
Equisetum hyemale 10+a
Erigeron canadensis 1+a, 2+a, 14+, 20+
Eriodictyon californicum 1+
Eruca sativa 20+
Erythroxylon Coca 1-b
Eschscholtzia californica 1+, 2+, 3+a, 11+a, 13+, 17+a, 19+
Eucalyptus globulus lab, 4+ab, 10+a, 11+ab, 19+
Euonymus atropurpureus 1+a, 6+a, 7+, 11+a, 16+, 19+a
Euonymus Europaeus 3+a
Eupatorium capillifolium 20+
Eupatorium maculatum 8+a
Eupatorium perfoliatum 1+a, 2+a, 3+a, 6+a, 8+a, 9+a, 11+a, 16+a, 17-
Eupatorium purpureum 4-a, 8+a, 17+
Eupatorium urticaefolium 3+a

Ferula foetida 1-b
Ficus Carica 6+a, 11+a
Ficus elastica 1ab, 11+ab
Foeniculum vulgare 1+a, 2+a, 3+a, 4+a, 6+a, 8-, 9+, 10+a, 11+a, 12+a, 13+, 14+, 15+a, 16+a, 17+a, 18+a, 19+, 20+a
Fraxinus Ornus 1ab
Fumaria officinalis 20+
Galega officinalis 1+a, 4+a, 6+a, 7-, 17+a, 20-
Gardenia jasminoides 19+
Gaultheria procumbens 1-, 3+, 6+a, 11-a, 15+, 16-, 20+a
Gelsemium sempervirens 1-, 4+a, 6+a, 17-, 19+a
Genista scoparia = Cytisus scoparius
Gentiana Andrewsii 1+a
Gentiana lutea 1-, 20-
Geranium maculatum 1+a, 2+a, 3+a, 4+a, 5+a, 11+a, 13+a, 14+, 16+a, 17+a, 19+, 20+a
Gillenia trifoliata 1+a, 11+a, 20+
Glycyrrhiza glabra 1-b, 11+a, 19+, 20+
Glycyrrhiza uralensis 20-
Gossypium arboreum 16+
Gossypium barbadense 3+a
Gossypium herbaceum 1+a, 4+a, 5+a, 11+a
Gossypium hirsutum 20+
Grevillea robusta 4+ab
Grindelia robusta 1+a, 11+a, 14+, 16+a, 20+
Grindelia squarrosa 1+a, 2+a, 3+a, 4+a, 6-, 8+a, 9+a, 10+a, 11+a, 14+, 16+a, 17+, 19+, 20+
Gypsophila paniculata 7-, 11+a
Hamamelis virginiana 1-, 3+a, 4+a, 6+a, 8-a, 9+a, 11+a, 16-a, 19+a
Hedeoma pulegioides 1+a, 3+a, 2-a, 4+a, 6+a, 8+a, 9+, 10+a, 11+a, 14+, 15+, 16+, 17+, 19+, 20+a
Helianthemum canadense 1+a
Helianthus annuus 1+a, 2+a, 3+a, 4+, 5+a, 6+a, 7-, 10+a, 11+a, 13+, 14+, 17+, 19+, 20+a
Helianthus tuberosus 20+
Helleborus niger 1+, 4+a, 11+a, 16-, 17+a, 19+
Helonias bullata 20+a
Hepatica triloba 1+a, 2+a, 11+a, 20+
Heuchera americana 1+a
Heuchera sanguinea 4-a
Hordeum distichon 3+a
Hordeum vulgare 1+, 2+
Humulus Lupulus 1+a, 2+, 3+a, 4+a, 5+a, 7+, 8+a, 9+a, 10+a, 11+a, 14+, 15+, 16+a, 17-, 19+, 20+
Hydrangea arborescens 1+a, 4+a, 6+a, 7+, 9+a, 11+a, 16+a, 19+a
Hydrastis canadensis 1+a, 2+a, 3+a, 4-a, 6+a, 7+, 8-, 11+a, 14-, 16+a, 17+ 19+, 20+a
Hyoscyamus albus 1+, 17+, 19+
Hyoscyamus muticus 2-, 20+a
Hyoscyamus niger 1+a, 2+a, 3-a, 4+a, 5+a, 6-, 8-a, 9-a, 10+a, 11+a, 14+, 15+a, 16+a, 17+a, 18+a, 19+, 20+a
Hyoscyamus pictus = H. niger
Hypericum perforatum 11+a
Hyptis spicata 20+
Hyssopus officinalis 1+a, 4+a, 6-, 11+a, 17+, 20+

Ilex opaca 4+a
Ilex vomitoria 4+a
Illicium anisatum = I. parviflorum
Illicium parviflorum 1-b, 17+
Inula Helenium 1+a, 2-a, 3+a, 4+a, 6+, 7+, 8+a, 11+a, 12+a, 15+a, 17+a, 19+,
20+a
Iris cristata 20+
Iris florentina 1+a, 2+a, 3+, 4+a, 6+a, 7+, 8-a, 11+a, 15+, 16+a, 17+a, 20+a
Iris germanica 1+a, 2+a, 3+a, 6+a, 7+, 8+a, 11+a, 16+a, 19+, 20+a
Iris japonica 3+a
Iris Milesii 20+
Iris pallida 1+a, 6+a, 7+
Iris Pseudacorus 11+a
Iris versicolor 1+a, 2+a, 3+, 4+a, 5+a, 6+a, 7-, 8-a, 9+a, 11+a, 14+, 15+a,
16+a, 17+a, 19+, 20+
Isatis tinctoria 10+a, 17+a, 20+a
Jambosa Caryophyllus 17+
Jasminum grandiflorum 20+
Jasminum officinale 19+
Juglans cinerea 2+a, 10+a, 11+a
Juglans nigra 1+a, 10+a, 11+a
Juniperus communis 1-, 14+, 15+, 16+a, 17+a
Juniperus Sabina 1-, 14+, 16-a
Juniperus virginiana 1-, 2+a, 3+a, 5+a, 9+a, 16+
Lallemantia iberica 2+a, 11+a, 15+, 20+a
Larix Larix 1-, 2+a
Laurus nobilis 11+ab, 19+
Lavandula Spica 1+a, 2-, 4+a, 5+a, 6-a, 11+a, 14-, 15+, 16-, 17+a, 20+a
Lavandula vera 1+a, 2-a, 3+a, 4+a, 6-, 8-, 11+a, 15+a, 16-, 17+, 19+, 20+a
Leonurus Cardiaca 1+a, 6+a
Leptandra virginica 1+a, 3+a, 8+a, 16+a, 19+
Levisticum officinale 1+a, 2+a, 6-, 9+a, 11+a, 16+a, 17+a, 19+, 20+a
Liatris spicata 1+a, 7+
Ligusticum filicinum 2-
Lilium tigrinum 1+a
Linum usitatissimum 1+, 2+a, 3+a, 5+a, 8+a, 11+a, 12+a, 14+, 15+, 16+, 17+a,
20+
Liquidambar Styraciflua 1ab
Lobelia cardinalis 1+, 3-a, 4+, 16+, 17-, 19+
Lobelia inflata 1+a, 2-a, 3-a, 4+a, 6+a, 9+a, 17+, 19+, 20+a
Lobelia syphilitica 1+a, 17-
Luffa cylindrica 1+a
Lupinus perennis 3+a
Magnolia fuscata 19+
Majorana = Origanum
Malva rotundifolia 1+a, 2+a, 3+a, 8+a, 17+
Malva sylvestris 1+a, 14+
Maranta arundinacea 1-b, 4+a, 17+
Marrubium vulgare 1+a, 2+a, 3+a, 4+a, 5+a, 6+a, 8-, 9+, 10+a, 11+a, 12+a,
13+, 14+, 15+, 16+, 17+, 20+a
Martynia louisiana 1+a, 17+a, 19+
Martynia proboscidea = M. louisiana
Maruta Cotula = Anthemis Cotula
Matricaria capensis 1+a, 11+a
Matricaria Chamomilla 1+a, 2+a, 3+a, 4+a, 5+a, 6-a, 7+, 8+a, 10+a, 11+a,
13+, 14+, 17+a, 19+, 20+a
Melaleuca Leucadendron 1-b

Melia Azedarach lab, 19+
Melilotus officinalis 1+a, 14+
Melissa officinalis 1+a, 2-, 3+a, 6+a, 7-, 8+a, 9+a, 11+a, 17+a, 19+, 20+a
Menispermum canadense 1+a, 6+a, 7+, 19+a
Mentha arvensis 2+, 20+a
Mentha arvensis var. piperascens 2+a
Mentha canadensis 8+a, 11+a, 20+
Mentha citrata 2+a, 3+, 6-, 7-, 8+a, 11+a, 14+, 16+a, 17+a, 20+a
Mentha crispa 1+a, 2+, 16+a, 17+a, 20+
Mentha longifolia 2+, 20+
Mentha piperita 1+a, 2+a, 3+a, 4+a, 5+a, 6+a, 7+, 8+a, 9+a, 11+a, 13+, 14+,
 15+a, 16+a, 17+a, 20+a
Mentha Pulegium 1+a, 2-, 20+
Mentha spicata 1+a, 2-a, 3+a, 4+a, 6+a, 8+a, 9+a, 10+a, 11+a, 13+, 14+, 15+a,
 16+a, 17+, 20+a
Mentha viridis = M. spicata
Metroxylon sp. lab
Mirabilis Jalapa 1+a, 6+a
Monarda didyma 1+a, 2+, 3+a, 11+a
Monarda fistulosa 1+, 2+a, 3+a, 6+a, 10+a, 17+a, 20+a
Monarda mollis 10+a
Monarda punctata 1+, 2+a, 6-, 7+, 10+a, 11+a, 13+, 14+, 16+a, 20+a
Morus nigra 1+a
Musa paradisica lab
Myrica Carolinensis 3+a
Myrica cerifera 3-a, 6+a, 19+a
Myrtus communis 19+
Nasturtium officinale 1+a, 11+a
Nepeta Cataria 1+a, 2+a, 3+a, 4+a, 6+a, 8+a, 9+, 10+a, 11+a, 14+, 15+a, 16+,
 17+a, 19+, 20+a
Nerium Oleander lab
Nicandra physalodes 1+a, 3+a, 6+a, 17+a, 19+, 20+a
Nicotiana repanda 1+
Nicotiana sanguinea 19+
Nicotiana Tabacum 1+a, 4+a, 10+a, 11+a, 17+, 19+
Nymphaea mexicana 11+a
Ocimum Basilicum 1+a, 2+a, 3+, 4+a, 6+a, 8+a, 10+a, 13+, 14+, 17+a, 18+a,
 19+, 20+a
Ocimum viridiflorum 20+
Oenothera Lamarckiana 19+
Olea europoea lab, 11+a, 19+
Origanum Majorana 1+a, 2-a, 4+, 6-, 10+a, 16+, 17+, 19+, 20+
Origanum officinale = O. vulgare
Origanum vulgare 1+a, 2-, 3-, 11+a, 17+, 19+
Oxytropis Lamberti 17+
Paeonia officinalis 1+a, 3+a, 7+
Panax quinquefolium 1+a, 2+a, 4+a, 7-, 8-, 9+, 11+a, 14-, 16-, 17+a, 19+, 20+
Papaver californicum 3+a, 6+a, 11+a, 14+, 15+
Papaver orientale 1+a, 3+a, 4+a, 6+a, 7-, 11+a, 14+, 16+, 19+
Papaver Rhoeas 1+a, 3+a, 6+a, 14+, 16+
Papaver somniferum 1+a, 2+a, 3+a, 4+a, 5+a, 6-a, 7-, 10-a, 11+a, 13+, 14+, 17+a
 18-a, 19+, 20+a
Papaver somniferum var. album 2+a, 3+a, 9+a, 14+, 16+a, 17+a, 19+
Parietaria officinalis 20+
Passiflora incarnata 1+, 19+
Pelargonium odoratissimum 1+a, 2+, 3+, 6-, 17+, 20+a

Pentstemon grandiflorus 1+a, 4+a, 7+
Pentstemon laevigatus digitalis 19+
Perilla frutescens 2+, 20+a
Perilla ocymoides 20+
Peucedanum graveolens = Anethum graveolens
Peucedanum Ostruthium 20-a
Philadelphus coronarius 1+a
Phlox ovata 19+, 20+
Phlox paniculata 19+
Phoenix dactylifera lab
Phytolacca acinosa 20+
Phytolacca decandra 2+a, 3+a, 4+a, 5+, 6+a, 7+, 8+a, 9+, 11+a, 13+, 14-, 16+a, 17+a, 19+, 20+
Picea excelsa 1-, 16+
Pimpinella Anisum 1+a, 2+a, 3+a, 4+, 6-, 11+a, 14+, 15+a, 16+, 17+a, 19+, 20+
Pinus Strobus 1+a, 2+a, 11+a, 16+a, 19+
Pinus sylvestris 11+ab
Piper nigrum lab, 4+a
Podophyllum emodi 1+a, 20+
Podophyllum peltatum 1+a, 2+a, 3+a, 4+a, 6+a, 7+, 8+a, 9+a, 11+a, 12+a, 14+, 16+, 17+, 19+, 20+a
Polygala Senega 1-a, 4-a, 8-, 16-, 19+, 20-
Polygonatum biflorum 1+a, 2+a, 3+a, 7+, 10+a, 11+a, 17+, 19+
Polygonatum commutatum 11+a
Polygonatum multiflorum 7+, 9+
Polygonum Bistorta 1+a
Polygonum Persicaria 4+ab
Polygonum tinctorium 20+
Polypodium vulgare 19+
Populus balsamifera 11+a
Populus nigra 1+a
Prunella vulgaris 11+a
Prunus communis 1-b, 11+a
Prunus Laurocerasus 1-b, 19+
Prunus serotina 1+a, 2+a, 3+a, 9+a, 11+a, 16+
Ptelea trifoliata 6+a, 11+a
Punica Granatum 1+a, 5+a, 6+a, 11+a, 16+a, 19+
Pycnanthemum albescens 2-a, 6+a, 20+
Pycnanthemum flexuosum 19+
Pyrethrum roseum 20+
Quercus alba 1-, 2+a, 4+a, 10+a, 11+a
Radicula Armoracia 1+
Reseda odorata 1+
Rhamnus alnifolia 20-
Rhamnus californica 11+ab
Rhamnus caroliniana 6+a
Rhamnus cathartica 1+, 4+a, 6+a, 8+a, 14+, 16+a, 19+, 20+a
Rhamnus Frangula 1-, 4+a, 6-, 8+a
Rhamnus Purshiana 1-, 2-a, 3+a, 8+a, 9+a, 11+a, 14+, 16-, 17+a, 19+a, 20+
Rheum giganteum 3-a
Rheum officinale 1+a, 2+, 4+a, 6-a, 8+a, 9+a, 11+a, 15+, 16+a, 17+, 19+
Rheum palmatum 1+a, 6-a, 8+a, 11+a, 16+a, 17+, 19+
Rheum rhaponticum 1+a, 6-a, 9+a, 11+a, 14+, 16+a, 19+, 20+
Rheum tanguticum 1+a, 6-a, 16+a
Rhus copallina 20+

Rhus diversiloba 20+
Rhus glabra 1+a, 2+a, 3+a, 4+a, 6+a, 9+a, 10+a, 11+a, 14- 16+a, 17-, 19+, 20+
Rhus Rydbergii 20+
Rhus Toxicodendron 4+a, 16+, 20-
Ricinus communis 1+a, 2+a, 3+a, 4+a, 5+a, 6+a, 7+, 8+a, 9+a, 10+a, 11+a, 12+a, 13+, 14-, 15+a, 16+a, 17+a, 18+a, 19+, 20+
Ricinus communis cambodgensis 17+
Ricinus communis sanguineus 17+
Ricinus zanzibarensis 1+a, 4+a, 7+, 17+a
Roripa Armoracia = Radicula Armoracia
Roripa Nasturtium 11+a
Rosa canina 11+a
Rosmarinus officinalis 1+, 2+, 3+a, 4+a, 5+a, 6+a, 8-, 11+a, 14+, 15+a, 16-, 17+a, 19+, 20+a
Rubia tinctorium 11+a, 20+a
Rubus Andrewsianus 6+a
Rubus cuneifolius 6+a, 14+, 16-
Rubus idaeus 1+a, 2+a, 3+a, 10+a, 11+a, 14+
Rubus nigrobaccus 1+a, 2+a, 3+a, 11+a, 14+, 16-
Rubus strigosus 2+a, 14+
Rubus villosus 2+a, 6+a, 7-, 10+a, 11+a, 14+
Ruellia ciliosa 2-, 20+a
Rumex crispus 1+a, 2+a, 3+a, 6+a, 8+a, 14+, 15+, 16+, 17+a, 19+, 20+
Rumex hymenosepalus 20+
Rumex obtusifolius 1+a, 3+a, 8+a
Rumex scutatus 11+a
Ruta graveolens 1+a, 2+a, 3+a, 4+a, 6+a, 9+a, 11+a, 13+, 15+, 17+a, 20+a
Salix alba 1+a
Salix fragilis 1+a
Salomonia commutata = Polygonatum commutatum
Salvia azurea 4+a
Salvia hispanica 6-a
Salvia officinalis 1+a, 2+a, 3+a, 4+a, 5+a, 6+a, 8+a, 9+a, 10+a, 11+a, 12+a, 14+, 15+, 16+a, 17+a, 19+, 20+a
Sambucus canadensis 1+a, 2+a, 7+, 9+a, 10+a, 11+a, 15+, 19+
Sambucus nigra 1+a, 6+a, 8+a, 14+
Samuela carnerosana 20-
Sanguinaria canadensis 1+a, 2+a, 3+a, 4+a, 6+a, 7+, 8+a, 9+, 11+a, 12+a, 14-, 16+, 17+, 19+, 20+
Saponaria officinalis 1+a, 4+a, 16+
Sarracenia purpurea lab
Sassafras variifolium 1-, 3+a, 4+a, 6+a, 7-, 8-, 9+, 11+a, 12+a, 13-
Satureja hortensis 1+a, 2+a, 3+a, 6+a, 8+a, 15+, 16+, 17+a, 19+, 20+a
Satureja montana 2-a, 17+a, 20-
Sassurea Lappa 20-a
Schoenocaulon officinale 20+a
Scopola carniolica 20+
Scopola Japonica 20+a
Scutellaria lateriflora 1-, 16+
Secale cereale 1+, 2+a, 3+a, 14+, 15+, 16+
Senecio aureus 1+a
Senecio canus 14+
Senecio Cineraria 11+a
Serenoa serrulata lab
Sesamum angolense 20+

Sesamum indicum 1-, 2+a, 4-, 6+a, 10+a, 11+a, 14-, 17-, 20+a
Sesamum orientale = S. indicum
Silphium laciniatum 19+
Silybum Marianum 19+
Sinapis alba 1+, 2+a, 3+a, 4+a, 5+a, 8+a, 11+a, 14+, 15+, 16+a, 17+a, 19+
Sinapis campestris, var. Rapa 1+, 3+a, 14+
Sinapis juncea 4+a, 17+a
Sinapis nigra 1+, 2-a, 3+a, 4+a, 5+a, 6+, 8+a, 11+a, 14+, 15+, 16+a, 17+a, 20+
Smilacina racemosa = Vagnera racemosa
Solanum carolinense 3+a, 11+a, 16+
Solanum Dulcamara 1+a, 2+a, 3+a, 8+a, 10+a, 11+a, 14+, 16+, 17-, 19+, 20+a
Solanum nigrum 1+a, 2+a, 3+a, 8+a, 16+, 17+a, 19+, 20+
Solanum weatherilla 1+
Solidago odora 11+a
Spathyema foetida 1+, 9+
Spigelia marilandica 1-, 2+a, 4+a, 6+a, 7-, 8-, 11-a, 13-, 16+, 20+a
Stillingia sylvatica 4+a, 19+
Strychnos toxifera 1-b
Symphoricarpos racemosus 1+a, 19+
Symphytum asperrimum 1+a
Symphytum officinale 1+a, 3+, 4+a, 6+a, 8+a, 10+a, 11+a, 14+, 17+a, 19+, 20+a
Tamarindus indica 4+ab
Tanacetum vulgare 1+a, 2+a, 3+a, 4+a, 5+a, 6+a, 9+a, 10+a, 11+a, 12+a, 14+,
15+a, 16+, 17+a, 18+a, 19+, 20+a
Taraktogenos Kurzii 3a
Taraxacum officinale 1+a, 2+a, 3+a, 5+a, 6+a, 9+a, 10+a, 14+, 15+a, 16+a,
17+a, 20+
Tephrosia Vogelii 20+
Thalictrum foliolosum 20+
Thea sinensis 1+, 4+, 6-, 14+
Theobroma Cacao 1-b
Thuja occidentalis 1-, 2+a, 15+
Thymus vulgaris 1+a, 2-a, 4+a, 5+a, 6-, 8+, 9+, 10+a, 11+a, 14+, 15+a, 16+,
17+, 19+, 20+a
Trifolium pratense 1+, 2+a, 3+a, 14+
Trigonella Foenum-graecum 1-, 2+, 3+a, 15+, 19+, 20+
Trillium erectum 1+a, 2+a, 3+a, 6-, 7-, 11+a, 14+, 16+, 20+a
Triosteum perfoliatum 9+, 20+
Tritoma Pfitzeri 4+a
Tussilago Farfara 11+a, 17+a, 20+a
Typha latifolia 1+a
Ulex europaeus 11+a
Ulmus fulva 1+a, 3+a, 14+, 16+a
Urginea maritima 1+a, 2+, 11-a, 20-
Ustilago maydis 10+a
Vagnera racemosa 1+a, 3+a, 9+, 11+a, 19+
Valeriana officinalis 1+a, 2-a, 3+a, 4+a, 6+, 8+a, 9+, 11+a, 16+a, 17+a, 19+,
20+
Vanilla planifolia 1-b
Veratrum album 17-
Veratrum nigrum 17-
Veratrum viride 1+, 3+a, 8-, 14+, 16+, 20+a
Verbascum Blattaria 3+a, 6+a, 19+a, 20+
Verbascum nigrum 1+a, 17+a, 19+
Verbascum phlomoides 1+a, 19+
Verbascum thapsiforme 1+a
Verbascum Thapsus 1+a, 2+a, 3+a, 6+a, 8+a, 9+a, 10+a, 11+a, 14+, 15+, 16+, 17+a
19+

Verbena hastata 1+a, 3+a
Verbena urticifolia 3+a
Veronica virginica 1+a, 16+, 19+
Vetiveria zizanioides lab
Viburnum americanum 20+a
Viburnum Lentago 1+a, 6+a, 16+
Viburnum Opulus 1+a, 2+a, 3+a, 4+a, 6+a, 8+a, 11+a, 14+, 16+a, 19+ , 5+a
Viburnum prunifolium 1+a, 4+a, 6+a, 7-, 9+a, 13+, 16+a, 19+
Viburnum rufidulum 6+a, 19+a
Vinca major 16+
Washingtonia longistylis 1+a
Xanthium speciosum 10+a
Yucca filamentosa 1+a, 11+a, 19+
Zanthoxylum americanum 1+a, 2+a, 6+a, 7-, 8+a, 11+a, 16+, 19+
Zanthoxylum bungei 20+a
Zanthoxylum Clava-Herculis 16+
Zanthoxylum piperitum 3+a
Zea Mays 2+a, 11+a
Zingiber officinale 1+a, 2-, 3+a, 4+a, 9+, 16+ab
Zygadenus elegans 17+

2/10/23/MP

SUPPLEMENTARY LIST

*Agremone rubra mexicana 16+
Bellis perennis 1+ 14-
Benzoin aestivale 3+
Bikukulla canadensis 3+ 16-
Bikukulla cucullaria 3+ 8+ 9+ 16-
Celosia cristata 1+ 9+
Ceratonia siliqua 1+ 9+a
*Conium basilicum 2+
*Datura coerulea flava 9+
*Datura entocaula (see D. ceratocaula) 8+
*Datura gigantea 8+ 9+
Dictamnus album 3+ 14-
Grevillea robusta 1+
Gysophila paniculata 1+ 9+
Hepatica triloba 1+ 3+ 7+ 8+ 9+ 12+ 14+
Lallemantia iberica 1+ 3+
Martynia louisiana 1+ 3+
Musa paradisiaca 9+a
Nicandra physalodes 2+ 3+ 9+ 11+ 14- 15+ 16+ 17+
Ornithogalum thrysoides 9+
Oxytropis lamberti 2+
Pentstemon grandiflorus 1+ 9+
Pentstemon laevigatus digitalis 3+ 9+
Philadelphus coronarius 1+ 3+ 9+ 16+
Phoenix dactylifera 9+a
*Pyrus sacca = (Malus sacca) 2+
*Rheum giganteum 1+
Smilacina racemosa = (Vagnera racemosa) 1+ 3+ 9+ 16+
Smyphoricarpus racemosus 1+ 6+ 16+
Trinia hispida 17-
Trinia taurica 17-
Typha latifolia 1+ 3+ 8+ 9+
Vagnera racemosa = (Smilacina racemosa)

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CHAPTER 32

Medicinal and Aromatic Plants

By W. W. Stockberger
Physiologist in Drug and Poisonous Plant Investigations, U. S. Dept. of Agriculture

The market demand for the products of medicinal and aromatic plants when compared with the demand for staple products such as cereals, fruits or vegetables, is relatively very small, and is not sufficient to make them promising crops for general cultivation. Many such plants which can be grown and prepared for market with little difficulty, bring but a small return, and hence their cultivation offers little prospect of profit. A number of high-priced medicinal plants must be given care for two or more years before a crop can be harvested, and, since expensive equipment is usually required for their successful culture and preparation for market, the production of such crops offers little encouragement to inexperienced growers who are looking for quick returns and large profits from a small investment of time and money.

Requirements for Medicinal Plants.—Several medicinal and aromatic plants, for which the demand is fairly constant, have been profitably grown on a commercial basis, but the success of the growers has been due largely to the care which they have taken to produce a uniform product of high quality. However, the production of drugs of high quality requires skilled management, experience in special methods of plant culture, acquaintance with trade requirements and a knowledge of the influence of time of collection and manner of preparation on those constituents of the drug which determine its value. Small quantities of drugs produced without regard to these conditions are apt to be poor in quality and so unattractive to dealers and manufacturers that the product will not be salable at a price sufficient to make their production profitable.

The agricultural conditions generally prevailing in the United States and in Canada are far more favorable to the growing of medicinal and aromatic plants as a special industry for well-equipped cultivators than as a side crop for general farmers.

The growing of medicinal plants in the United States has hardly passed beyond the experimental stage, and although several of these plants promise satisfactory profits in suitable localities, any general attempt to grow them on a commercial scale would soon result in over-stocking the market. However, the demand for such plants as anise, belladonna, car-

away, coriander, digitalis and sage is at present large enough to make them worthy of consideration.

Anise (*Pimpinella anisum*) is an annual plant grown for its aromatic seeds. It is cultivated on a small scale in Rhode Island, and is suited for localities similar in climate to that state. The best soil for anise is a light, moderately-rich and well-drained loam. The plant is very sensitive to unfavorable weather conditions, but in a good season the yield of seed should be from 400 to 600 pounds per acre. About 2000 acres should produce the average quantity of seed annually imported into this country. The price usually ranges from 6 to 8 cents a pound.

Belladonna (*Atropa belladonna*) is an important drug plant for which there is a steady demand. It has been cultivated in New Jersey, Pennsylvania and California, although not very successfully from a commercial point of view. It is apparently better adapted to the warmer states than to the colder regions where it is likely to winter-kill. Belladonna thrives best in deep, moist, well-drained loam containing lime. Sowing seed in the field usually gives very poor results, but sowing seed in the greenhouse and transplanting like tomatoes is usually successful. The cost of growing belladonna is high, owing to the large amount of necessary hand labor. Five hundred pounds of dry leaves per acre is considered a fair yield. At the end of the second year about 1000 pounds of dried root per acre may be harvested. The prices in the wholesale drug markets have been from 14 to 25 cents a pound for the leaves and from 9 to 18 cents a pound for the roots. Prices to growers have been proportionately less.

Caraway (*Carum carui*) is an annual, cultivated for its aromatic seeds, which are used medicinally and for flavoring. It grows and fruits well over a considerable portion of the United States, especially in the north and northwest, but its cultivation in this country has never assumed commercial proportions. Soil of a somewhat clayey nature and containing a fair proportion of humus and available plant-food is particularly suited to caraway, but the plant generally grows well in any good upland soil which will produce fair crops of corn or potatoes. The average yield of seed per acre is about 1000 pounds. At this rate about 2700 acres would be required to produce the quantity of seed annually imported. Anyone undertaking the cultivation of this plant might well consider growing dill and fennel also. Caraway seed is valued at about $6\frac{1}{2}$ cents a pound.

Coriander (*Coriandrum sativum*) is also grown for its aromatic seeds and in its requirements and method of culture is very similar to caraway. The yield of seed is quite variable, but from 500 to 800 pounds per acre may be expected. If the average yield were 650 pounds per acre, 2000 acres would be required to produce the quantity of seed annually imported. The seed is valued at approximately 3 cents a pound.

Digitalis or Foxglove (*Digitalis purpurea*) is an important drug plant for which there is a constant demand. The leaves are used in medicine. Although widely grown in flower gardens as an ornamental, it has not yet

been grown on a large scale in this country as a drug crop. This plant thrives best in ordinary well-drained garden soils of open texture. Sowing the seed in the field is usually unsuccessful. For good results they should be sown in seed-pans or flats in the greenhouse. When danger of frost is past the plants should be hardened off and transplanted to the field. Digitalis does not flower until the second year, when the leaves may be collected. Probably 600 pounds of dry leaves per acre may be obtained under favorable conditions. The wholesale price of leaves ranges from 8 to 40 cents a pound, averaging about 15 cents.

The Common Sage Plant (*Salvia officinalis*) is easily cultivated and will grow in almost any well-drained fertile soil. There is a good demand for American leaf sage, which sells at a considerably higher price than the imported article.

The dry herb or leaves of a number of aromatic plants form marketable products for which there is a small demand, but as a rule these plants are grown for the essential oils which they yield. The principal essential oils produced in the United States from cultivated plants are: peppermint, spearmint, tansy, wormwood and American wormseed. The price of imported sage is 3 to 5 cents a pound. American sage is usually a little higher.

Ginseng (*Panax quinquefolium*) is a fleshy-rooted herbaceous plant native to this country and formerly of frequent occurrence in shady, well-drained situations in hardwood forests from Maine to Minnesota and southward to the mountains of Georgia and the Carolinas. It has long been valued by the Chinese for medicinal use, though rarely credited with curative properties by natives of other countries. Under cultural conditions, ginseng should be shielded from direct sunlight by the shade of the trees or by lath sheds. The soil should be fairly light and well fertilized with woods earth, rotted leaves or fine raw bone meal, the latter applied at the rate of one pound to each square yard. Seed should be planted in the spring as early as the soil can be worked to advantage, placed 6 inches apart each way in the permanent beds, or 2 by 6 inches in seed-beds, and the seedlings transplanted to stand 6 to 8 inches apart when two years old. Only cracked or partially germinated seed should be used.

Ginseng needs little cultivation, but the beds should be at all times kept free from weeds and grass and the surface of the soil slightly stirred whenever it shows signs of caking. A winter mulch over the crowns is usually essential, but it should not be applied until freezing weather is imminent and should be removed in the spring before the first shoots come through the soil.

The roots do not reach marketable size until about the fifth or sixth year from seed. When dug, they should be carefully washed or shaken free of all adhering soil, but not scraped. Curing is best effected in a well-ventilated room heated to about 80° F. Nearly a month is required to properly cure the larger roots, and great care must be taken in order to prevent moulding or souring. Overheating must also be avoided. When

well cured the roots should be stored in a dry, airy place until ready for sale. A market may be found with the wholesale drug dealers, some of whom make a specialty of buying ginseng root for export.

The price of cultivated ginseng root, as quoted in wholesale drug lists, has ranged during the past few years from \$5 to \$7.50 per pound.

A detailed account of ginseng culture is given in Farmers' Bulletin 551, entitled "The Cultivation of American Ginseng."

Peppermint (*Mentha piperita*) is frequently found growing wild throughout the eastern half of the United States, and can be grown under cultivation on any land that will produce good crops of corn. It is grown commercially with most success on the muck lands of reclaimed swamps in southern Michigan and northern Indiana. On good land the average yield of oil per acre is about 30 pounds, but as the yield is variable, approximately 15,000 acres of land are required to produce the annual market demand. It is valued at about \$2.50 per pound.

Spearmint (*Mentha spicata*) is very much like peppermint in its requirements, but can be grown successfully on a wider range of soils. On ordinary soils the yield of oil varies from 10 to 20 pounds per acre, but on muck lands the yield is usually only a little less than that of peppermint. The annual market requirement for spearmint oil is about 50,000 pounds. The oil has an average value of about \$3.30 a pound and the dry herb 3 to 4 cents a pound.

Tansy (*Tanacetum vulgare*) is a hardy plant which grows well on almost any good soil, but rich and rather heavy soils well supplied with moisture favor a heavy growth. The yield of oil varies, but about 20 pounds per acre is a fair average. The annual market requirement of this oil probably does not much exceed 3000 pounds. It is valued at about \$2.60 a pound.

Wormwood (*Artemisia absinthium*) is a hardy plant which can be grown almost everywere, but commercially it is usually grown on fairly rich, moderately moist loams. It is cultivated on a small commercial scale chiefly in Michigan and Wisconsin. The annual production of oil is about 2000 pounds, which is apparently sufficient to satisfy market requirements. It is valued at about \$2.40 per pound.

American Wormseed (*Chenopodium anthelminticum*) is a coarse weed which grows well in almost any soil. The yield of this oil varies, but about 30 pounds per acre is a fair average and the annual production is about 5000 pounds. It is gaining in importance largely through its use as a remedy for hook-worm. The price ranges from \$1.40 to \$5.50 a pound.

Additional Equipment.—In addition to the usual agricultural equipment the producer of essential oils must provide a suitable distilling apparatus, since such oils are usually derived from plants by steam distillation. The cost of setting up a still will depend upon what facilities are already at hand and the size and efficiency of the apparatus installed. It may easily range from a small sum to several thousand dollars.

Where successful production of medicinal plants has not been demonstrated it should be determined on small experimental plats before undertaking commercial plantings.

REFERENCES

Michigan Expt. Station Bulletin (Special) 72. "Some Gingseng Troubles."
U. S. Dept. of Agriculture Bulletin 26. "American Medicinal Flowers, Fruits and Seeds."
Farmers' Bulletins, U. S. Dept. of Agriculture:
531. "Larkspur or Poison Weed."
551. "Cultivation of American Ginseng."
613. "Goldenseal Under Cultivation."
694. "The Cultivation of Peppermint and Spearmint."
663. "Drug Plants Under Cultivation."

MEDICINAL PLANT GARDENS.*

By Dr. W. W. Stockberger, Physiologist in Charge of Drug Plant an Poisonous-Plant Investigations, Bureau of Plant Industry, United States Department of Agriculture.

It is not my intention in this paper to present a descripti account of medicinal plant gardens in general, or even to discu the more important ones of this country, except in so far as refer ence to them may be necessary by way of illustration. I sha endeavor, however, to point out what to me appear to be so popular misconceptions concerning the scope and function of su gardens, and to suggest how they may be made to increase the usefulness to Materia Medica and Pharmacognosy.

For the purpose of this discussion, medicinal plant garde may be regarded as falling under one of two general classes, t first being pedagogic, the second industrial. The pedagogic gar is, naturally, an adjunct of a school of pharmacy or of a bot garden. Its scope includes all medicinal plants that are adapted existing soil and climatic conditions, supplemented by greenhou facilities. Its function is to familiarize students with the habit a appearance of the entire living plant, some part of which is u as a plant drug, to supply the need for authentic specimens f observation and demonstration in the classroom, and to furni materials for research work on the morphology and chemical co stituents of drug plants. Necessarily it will be found desirable grow a large number of species in this type of garden, but, owi to the cost of maintenance, the space which can be devoted to a one species will be very small.

The industrial garden, on the other hand, is an adjunct of pub or private enterprise, the object of which is to give additional inf mation concerning our agricultural resources. Its scope is the sa as that of the pedagogic garden, but it differs very materially function, which is to serve for the determination of the adaptabil of medicinal plants, not only to soil and climatic conditions, b to economic conditions as well. In the industrial garden a lar number of species will be tested on a small scale to determi whether the soil and climate are suitable for their growth; then t

* A paper read before the Scientific Section of the A. Ph. A. at th Detroit meeting, 1914.

few promising ones must be tried out on an area large enough to yield reliable data on the actual conditions of commercial production. A considerable acreage of land is indispensable for this type of garden if the results secured therein are expected to have much economic significance.

There is no lack of evidence that the general public often, if not as a rule, fails to differentiate the functions of the pedagogic and industrial gardens, since advice is freely sought from both regarding the production of medicinal plants for the sole purpose of deriving profit therefrom. It is also an open question whether this distinction in function is in every case clearly understood by those responsible for the management of medicinal plant gardens. Statements sometimes unguarded, or not properly qualified, and sometimes based upon inconclusive and insufficient data, have on several occasions inspired the imagination of writers for the popular magazines or daily press, and, as a result, visions of large and easy profits have been portrayed under various alluring titles, as, for example, "Big Profit from Drug Weeds," "The Herb Grower Has a Chance at an $18,000,000 Business," "A Profit of One Hundred Dollars per Acre from Growing Medicinal Weeds." Moreover, the widespread interest in the possibility of growing medicinal plants for profit which has been developed in this country during the past decade has been capitalized by a number of crafty promoters, who use the mails and the columns of journals and magazines to disseminate flamboyant advertisements of the enormous profits which may be made by growing certain medicinal plants. Frequently the name of the plant is withheld until the victim has remitted from one to five dollars, for which he receives practically valueless instructions for the cultivation of some plant poorly adapted to our economic conditions. A typical get-rich-quick scheme of this class is explained thus: "It has to do with a certain plant which grows like a weed; it is cut and cured like hay and sells for 45 cents per pound, which is at the rate of $900 per ton." The investment of one dollar brings the name of the herb, with the further information that the product of one acre will sell for $1800! As a matter of fact, the commercial cultivation of this plant is almost unknown in the United States, and there is yet no established market for the American product.

These illustrations will account for the doubt which has arisen

in my mind as to the propriety of purely pedagogic gardens bein used as a basis for generalizing on the question of drug growin for profit. In agricultural experimentation it is well recogniz that the results from small trial plots must be interpreted with du regard for the large factor of error, which is always present. Wit proper care and attention it is relatively easy to grow a luxurian crop of any one of a number of drug plants on a square rod o good garden soil, but what can be done under ordinary agricultura conditions on one or more acres can not be calculated therefro by "a simple sum in arithmetic," as one writer has naïvely said.

There are numerous well-authenticated instances in which th production of some medicinal plant has resulted in a fair profi but there is yet no evidence at hand to justify the belief that satis factory results can be secured without some practical experienc in gardening, some knowledge of the requirements of crude drug and due regard for economic conditions.

Every pharmacist and physician is, or should be, interested i obtaining crude drugs of highest quality and standard efficienc but material progress toward the attainment of this end will not b favored by encouraging a large number of persons to become sma producers. The result of small individual collections, varying widel as to time, place, and method of gathering, is seen in the misce laneous aggregates all too frequently found in our crude dru markets, and unless a perpetuation of this condition is desirabl little encouragement should be given to the suggestion that whoev has a small back yard available may become a producer of pla drugs.

The educational opportunity open to the pedagogic gardens almost limitless. The dissemination of knowledge to countle individuals not having access to the garden itself regarding the hi tory, geographic distribution, methods of preparation, and uses c crude drugs may be accomplished through illustrated lectures an carefully prepared articles written for the less technical periodical Such misconceptions as, for example, that the production of ipeca in New England and vanilla beans in Iowa is a commercial poss bility, or that stramonium is produced by a "melon weed," are a too prevalent and should be corrected. But educational work alon this line deserves little tolerance unless inspired by some motiv more commendable than that of merely arousing interest in growin

drug plants, otherwise the whole movement will sooner or later be discredited. Recently a reputable pharmaceutical journal published an article in which the writer set forth at some length the possibilities for the commercial production of a certain drug plant in the Southwest. A request for further information brought forth from this writer the astounding statement that he had no personal knowledge of conditions in the Southwest, but, *having grown this plant in one of the northern States*, he saw no reason why it should not be profitably grown in the Southwest, " on rocky and otherwise unprofitable land, on hillsides or arid desert soil." In this case the motive was evidently merely the arousing of interest, and the writer mentioned displayed a fine disregard for the practical difficulties attending the growing of the plant in question, which sharply localize the areas on which it may be economically produced.

The time is certainly ripe for injecting into discussions and recommendations regarding the cultivation of medicinal plants some of the sanity and discrimination which characterizes conservative business operations. Such a course is necessary if the interest already aroused is to be retained and directed along lines productive of beneficial results. It should be remembered that the expense of agricultural operation varies widely according to location. In some localities the outlay for farm labor will be three and one-half times as much as in others. Sometimes we find a low expense for labor associated with a heavy outlay for fertilizers, sometimes heavy expense for both labor and fertilizers, and, again, low expense for both. The complications introduced by these factors alone render it practically impossible to make any safe general statement as to the profitableness of drug growing. Furthermore, two localities separated by a distance of less than fifty miles may present a totality of conditions so different that a drug-growing enterprise which could probably be conducted at a profit in the one would with equal probability fail absolutely in the other.

I do not wish to be understood as taking the position that there is no opportunity in the cultivation of medicinal plants, for I have abundant evidence that, given the *necessary favorable conditions*, a fair return may be expected from several drug crops. On the other hand, I also have abundant evidence that hundreds of persons have received the impression that drug crops can be grown by anybody anywhere at a profit far in excess of that to be obtained from ordi-

nary cultivated crops. I am convinced that in some cases optimism and enthusiasm have been allowed to outrun common sense, but if in the future, due consideration is given to the fundamental prin ciples of agricultural economics, I believe that a rational attitud toward commercial drug-plant cultivation may be developed.

The founders of the several excellent pedagogic gardens whic are now maintained in connection with certain schools of pharmac have inaugurated a movement which promises much for the futu of Materia Medica and Pharmacognosy. It is sincerely to be hope that their example will lead to the establishment of such gardens i connection with each of the 75 or more schools of pharmacy in th United States, and to an extension of the scientific study of medicin plants. The problems demanding attention are very numerous, bu some of the lines of study and investigation which need to be empha sized are those concerning the adaptation and acclimatization medicinal plants, the conditions under which the active principles plants are formed, and the behavior of the plants themselves und varying conditions of climate and culture. Moreover, the selecti and breeding of medicinal plants not only promises to yield resul of great practical importance, but also affords a field for the wid scientific activity.

It is to be regretted that at present there is no satisfactory w in which the investigations being made upon medicinal plants different sections of this country can be properly correlated a reduced to form for definite comparison. Especially desirable is practical basis of correlation for studies of the variation in pl constituents, due in part, at least, to differences in geographi location. When two more or less widely separated workers atten to compare the results of their studies, it frequently happens th they experience the greatest difficulty in harmonizing their resu This is due in part to differences in the response which plants ma when under different environmental conditions, in part, probab to variations in the method of procedure followed in the cultivati curing, and analysis of the plant, and in part, no doubt, to diffe ences in the genetic relationship of the plants studied by the respe tive investigators.

There seems to be an opportunity for some arrangement or mutu agreement between the representatives of our various medicin plant gardens under the terms of which multiplicate samples of seeds

or plants of common parentage could be distributed for the production of plants to be used experimentally. If under such an agreement uniformity of treatment throughout the processes of culture, curing, and analysis could be secured, comparison of results would be much more profitable than at present, and the tabulation and summarizing of the results of experimental work conducted along the lines indicated in a number of localities would permit the drawing of conclusions having a significance far greater than those that can be reached by a single isolated worker. The suggestions here offered contemplate nothing like a general coöperative investigation, but rather the adoption of what might be regarded as a standard method of procedure analogous to official methods of analysis, etc. The tabulation and summarizing of results might well follow individual publication, as no other course is likely to give satisfaction.

In conclusion, I wish to say that the resources of the experimental drug gardens of the Office of Drug-Plant Investigations, Bureau of Plant Industry, are open to any school of pharmacy desirous of starting a medicinal plant garden, as are also the facilities of that office for effecting the distribution of material for experimental purposes, and for furthering the collection and compilation of data on the cultivation of medicinal plants under great diversity in conditions of growth.

Bureau of Plant Industry,
United States Department of Agriculture,
August 18, 1914.

A STUDY OF SOME OF THE METHODS FOR THE DETERMINATION OF CALOMEL IN CALOMEL TABLETS.

By J. W. Marden and O. E. Cushman.

In the determination of calomel in calomel tablets there is a choice of several methods of procedure. Since the composition of calomel tablets varies considerably, different methods apply better to some samples than to others, and care must be exercised in selecting a method which will give correct results; many fillers, such as talc, sodium bicarbonate, gum acacia, confection of rose, etc., are often found.

Possibly the most widely used method for the analysis of mercurous mercury is the gravimetric estimation as the sulphide.[1] In this

[1] Treadwell-Hall, *Anal. Chem.*, vol. ii, p. 168; Olsen, Quant. Chem. Anal., p. 79.

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PHYSIOLOGICAL OBSERVATIONS ON ALKALOIDS, LATEX AND OXIDASES IN PAPAVER SOMNIFERUM*

RODNEY H. TRUE AND W. W. STOCKBERGER

In the summer seasons of 1902–4, while carrying on a series of investigations on the opium poppy, the writers made a number of observations on the occurrence and behavior of certain oxidizing enzymes present in this plant. These results, although verified by a number of repetitions, were not published at that time, it being then intended by the writers to broaden somewhat the scope of the investigation before bringing forward their results. However, the continuance of the work was subject to a number of contingencies and was not developed in the manner anticipated. Although much has happened since then that might concern the interpretation of the data then gathered, the facts themselves seem to point to certain broad conclusions which now as then are likely to interest the plant physiologist. Accordingly, it has seemed still in order to present these results with this explanation.

The plant material here used was grown by Mr. S. C. Hood, scientific assistant, from authentic seed at Burlington, Vermont, in the experimental grounds of the Vermont Agricultural Experiment Station in connection with co-operative work being carried on between that station and the Bureau of Plant Industry.

DISTRIBUTION OF OXIDASES AND OF LATEX IN THE PLANT

The oxidase was detected chiefly by means of the guaiac tincture test for oxidases of the laccase type used by Schönbein[1] and many

* Published by permission of the Secretary of Agriculture.

[1] Schönbein, C. F. Ueber das Vorkommen des thätigen Sauerstoffs in organischen Materien. Journ. Prakt. Chem. 105: 203–308. 1868.

[The Journal for December (2: 505–582) was issued Jan. 3, 1916]

others. The peroxidase reaction was studied chiefly by means of the guaiac tincture followed by hydrogen peroxide. The guaiac test was supplemented by the test with pyrogallol and sometimes with gallic acid.

The presence of an oxidase of the general type represented by the laccase of Bertrand and by the tobacco oxidase of Loew was easily demonstrated. This oxidase as found in the freshly expressed juice gave a reaction with guaiac tincture, pyrogallol and gallic acid. After precipitation with an excess of strong alcohol, the solution obtained on redissolving the precipitate in distilled water gave an intense reaction. Rough tests showed that in such solutions both the oxidase and the peroxidase reactions were inhibited by an exposure for four minutes to a temperature of 70° C. It appeared that this limit varied with the concentration and age of the enzyme solution. This inhibition of the reaction made it clear that the causes of the color changes lay in something easily modified by heat, not in any of the more stable substances shown to be capable of bringing about like color changes in the guaiac tincture. It having been seen in preliminary tests that the oxidase and peroxidase reactions in the different organs of the plant differed widely in intensity, systematic data were sought on this point.

In order to get evidence on the question of distribution from fresh materials, the reagents were taken to the field and applied to freshly cut surfaces of the growing plants. Here the order of intensity shown by the guaiac reaction agreed with that seen in the discoloration of the pulp. The most marked oxidase reaction was always seen in the more active younger parts of the plant. The fresh roots showed an almost complete lack of oxidase while the buds and petals were heavily loaded with it. The conclusion seemed justified that in this plant the intensity of the oxidase reaction increases from the base toward the summit of the plant. Similar tests for the peroxidase reaction showed clearly the presence in all parts of the plant of substances causing this reaction and no marked difference in intensity seemed to characterize any special part of the plant unless a greater activity was seen in the buds and flower parts.

The question immediately presented itself as to what particular tissues or substances contained the oxidases. When the guaiac tincture was applied to the cut surface of the growing plant, the drops of latex which instantly appear first gave the oxidase color reaction

and remained much more intensely colored than the surrounding parts. When the latex was gathered by allowing the exuding drops to fall into a little distilled water an intense oxidase reaction was likewise seen. A study of the reaction on cut surfaces of leaves, stems and roots showed that the reaction was most intense where the latex was most abundant and that, indeed, as far as could be judged by this crude method, the latex content and oxidase reaction ran roughly parallel. The petals seemed to form a possible exception in giving an intense oxidase reaction while yielding little latex on wounding. However, the mass of tissue here is small and the very numerous small branches of the latex system may offer obstacles to the quick and abundant outflow of the latex such as would be strikingly seen on the cut surfaces of the more massive structures.

Further interesting light on the relation of the latex to the oxidase reaction came from a study of young poppy plants. Plants from 30 to 45 centimeters tall on which no flower buds had as yet appeared gave no clear oxidase reaction on cut surfaces, and the plant juices were watery rather than milky. As the plants developed the suspended matter giving to the latex its characteristic milky appearance increased and the oxidase reaction also appeared as already described. Whether this coincidence between the degree of milkiness of the latex and the intensity of the oxidase reaction has any special physiological significance can not now be stated. However, a number of wild plants having a milky juice were tested in the same way and a strong oxidase reaction appeared whenever the juice was treated with the guaiac tincture. The addition of H_2O_2 in these cases gave a very strong reaction for peroxidase. The following plants were tested: *Euphorbia maculata*, *Sonchus asper* and *Hieracium aurantiacum*.

The study of these reactions on fresh plants was supplemented by a laboratory examination of extracts prepared from different parts of the poppy plant. Normal poppy plants approaching maturity were carefully dug up, promptly and thoroughly cleaned and quickly cut into the following portions: Roots, lower stems, leaves, upper stems, capsules (immature), and flower buds. Each portion was quickly reduced to a fine pulp by use of a meat grinder, placed in a clean beaker similar in size and shape to the others used in the series and macerated over night in a volume of water proportional to the weight of the fresh pulp and sufficient to cover it. On the following morning the various macerations were found to have undergone a

change of color in the surface layer. The root material showed but a slight change of color, a grayish tint being seen rather than the reddish-brown color characteristic of the others. The material from the stem portions was slightly reddish brown, with a distinctly more intense color toward the upper part of the plant. This intensity further increased in the leaf material. The reaction still more intense in the capsules was exceeded by the flower buds which gave a most intense color. The petals and stamens were also shown by separate tests to be most active. Tests with litmus paper showed that the extracts from the petals, lower stem and roots were neutral. All others showed a trace of acidity. In so far as this evidence went it seemed to indicate that the oxidase reaction was most abundant in the younger, growing parts of the plant.

The solutions of the different portions of the plant after being expressed from the pulp were treated with three volumes of commercial alcohol and briskly shaken. Precipitation was complete after several hours when the precipitate was filtered. This precipitate was dissolved in water as far as possible but a considerable insoluble residue always remained. The resulting solutions when tested for the oxidase reaction gave distinct though not strong oxidase reactions which in order of intensity was nearly the reverse of the order seen in macerated materials after standing over night in the beakers.

This interesting result seemed to indicate several possibilities. If it be assumed that the browning of the surface layer of the watery extract was caused by the precipitated substances responsible for the blue color in the guaiac tincture an apparent contradiction in the evidence seemed to exist here. That it may, however, be apparent only seemed to follow from further experiments.

In the course of the preparation of enzyme-containing precipitates the ground pulp was macerated in water over night in loosely covered beakers. In the morning a more or less deeply colored brownish layer was seen at the top of the material. Portions of the solution which were carefully drawn off by means of a pipette from this colored layer and from the uncolored portion near the bottom showed a marked difference in their activity toward the guaiac solution. Although the color of the superficial layer seemed to indicate that marked oxidative activities had taken place in the region of contact with the air, but a very faint oxidase reaction was seen when the reagents were employed. On the other hand, the uncolored portion from the

bottom of the beaker gave a strong oxidase reaction. The cause of the disappearance of the oxidase reaction from the brown surface solution was next sought.

A very active oxidase solution was prepared by quickly grinding up buds in distilled water and filtering off the solid portions. This solution which immediately began to take on a brownish tinge on exposure to the air was quickly divided into two portions. One was put into a bottle which was completely filled, tightly stoppered and placed near the bottle through which air was being drawn. After about 20 hours the aerated solution was found to have taken on a dark-reddish brown color suggesting a coffee infusion indicating that an intense action had taken place under the influence of the greatly increased air contact. This solution showed an almost complete loss of the oxidase reaction when tested with guaiac tincture. The second portion preserved out of contact with the air and which showed no clear deepening of color during the interval gave a very strong oxidase reaction. Both solutions were neutral to litmus. It seemed to be indicated that either the oxidase had been exhausted during the reaction if still present or had been in some way inactivated.

It was thought possible that products of oxidation that without doubt had accumulated in the solution during aeration might in some way have inhibited the oxidase reaction. Accordingly an attempt was made to free at least partially the supposed enzyme from these products. The dark colored solution was treated with three volumes of commercial alcohol and the resulting bulky flocculent pale-colored precipitate filtered off after about two or three hours. The filtrate retained the brown color almost completely. The washed precipitate was thrown into a volume of distilled water equal to about half the volume of the original solution. As is usual with such precipitates a considerable part remained undissolved. The solution obtained carried a trace of color but not sufficient to obscure a definite oxidase reaction. Test with guaiac tincture, however, failed to give even minimum traces of such a reaction. Since by the same method active oxidases were regularly prepared from fresh material, it was clear that the process of isolation had not destroyed the enzymes. Although a considerable part of the products of enzyme action had without doubt been removed no return of oxidase activity was seen, a fact strengthening the suggestion that the enzyme was exhausted or inactivated through use. It is of course not clear to what degree the process of

precipitation and re-solution separated the oxidase from the oxidation products. In so far as color may be accepted as an index, it seems probable that a very considerable degree of separation was effected.

Taking all evidence into account, the conclusion was strongly indicated that the enzyme was used up or inactivated during the course of the reaction. It is interesting to note in this connection the similar conclusions arrived at by Bunzel[2] in his recent and more exact studies.

In order to get further evidence on this point, a series of experiments was made with the juice of potato tubers. Freshly prepared aqueous extracts made in the same way as the poppy extracts gave active oxidase and peroxidase reactions. The solutions darkened very rapidly on standing and when tested after four hours gave no oxidase reaction. This solution was then treated with two volumes of strong alcohol, filtered after about an hour and the precipitate dissolved in distilled water. The resulting solution gave no oxidase reaction. The conclusion drawn from the poppy experiments seemed to be strengthened by the evidence gained from the work done on potatoes. This conclusion is hardly compatible with a catalytic explanation of oxidase action.

It is recalled that in the making of opium, the crude material from which morphine and several other alkaloids are obtained, the essential process consists in so scarring the full-grown but still green capsules as to cause the latex to run out onto the surface where in contact with the air it dries down from a thinly fluid milky juice to the dark brown, gummy substance known as opium.

Distribution of Alkaloids in the Plant

In view of the relations just discussed, it seemed desirable to ascertain in how far the distribution of the alkaloid, morphine, might show a relation to the distribution of latex and of the oxidase reaction. Accordingly, a number of full-grown plants of the black-seeded form of the opium poppy a meter or more high were brought in to the laboratory where they were cut up as quickly as possible into the following parts: Roots, lower stem, midstem, upper stem, leaves, flower buds, and capsules. The capsules were approximately full-

[2] Bunzel, H. H. The measurement of the oxidase content of plant juices. Bulletin 238, Bureau of Plant Industry, U. S. Dept. Agric. 1912.

[illegible]

grown but were still green and full of sap. Each of these portions was separately ground to a pulp and twice extracted with a hydro-alcoholic menstruum. The green weight was taken just before grinding and the pulp after extraction was expressed and again weighed. The amount of crude morphine was then determined for each extract and calculated with reference to the quantity of the plant material which had yielded it.

The results of the morphine determination are expressed in a ratio of morphine present to the same unit weight of plant material calculated for each of the plant samples. The relative yields of morphine were as follows:

Root	29.0	Lower stem	2.6	Midstem	1.3
Upper stem	2.2	Leaves	6.1	Buds	102.0
Capsules	42.0				

Some morphine was found in all parts of the plant. The roots in which there seemed to be but little latex yielded morphine in fair quantity, while in all parts of the stem the amount was almost negligible. However, the highest yield of morphine by far was found in the buds and capsules, both actively developing structures. Disregarding the root, the distribution of morphine in the plant seemed to conform fairly well to the distribution of oxidases and latex as previously noted.

The suggestion of a direct relation between the oxidases and morphine formation led to a series of observations on the latex itself. It was found that when the latex flowing from the freshly incised capsules was allowed to fall directly into strong alcohol the material failed to respond to the usual qualitative tests for alkaloids, while similar samples collected at the same time either in water or in a petri dish where it was allowed to dry gave all of the usual reactions with the common alkaloidal reagents. Fresh latex from the same plant was repeatedly collected both in alcohol and in water and tested with the result just described.

Conditions of Alkaloid Formation in the Plant

The results would seem to be explained on the assumption that morphine does not exist preformed either in the living plant or in the latex but develops in the latter when it is exposed to the action of the air or in the plant through oxidation changes as the tissues mature and

die. Apparently the oxidase which occurs so abundantly in the latex may be credited with playing an important part in these oxidations. Morphine was absent in the solutions of the free latex only when oxygen was excluded or when the action of the oxidases was inhibited.

Further evidence on the part played by the air in the production of morphine was added as a result of an experiment in which fresh capsules of the poppy were dried in an atmosphere from which air (oxygen) was excluded.

Three uniform lots of fresh poppy capsules of normal growth were collected on the tenth day after the fall of the petals.

Lot I was spread out on a bench at a north window of the laboratory and allowed to dry by simple exposure to the air.

Lot II was dried out in an air bath oven at a temperature varying between 90 and 100° C.

Lot III was dried out in an atmosphere of CO_2. A Remington copper still filled with CO_2 was taken to the poppy field where selected capsules were cut off and immediately put into the still through a suitable opening. This opening which was near the top of the container was tightly stoppered except when opened to receive the capsules. When the desired quantity of capsules had been collected, the still was brought back to the laboratory and in large part submerged in a water bath in which from 8 o'clock a.m. to 5 p.m. the water had a temperature close to the boiling point. No heat was applied during the night. As soon as the still with its load of capsules was in position in this water bath connection was made with a cylinder of liquid CO_2. The gas passed first through a wash bottle containing sulphuric acid, thence through a glass tube dipping into a vessel of boiling water in which the gas was heated. From here it was carried to the bottom of the still where it diffused among the capsules. The excess CO_2 and the vapor from the drying capsules escaped through a small opening in the top of the still. A continual flow of gas was maintained day and night until the capsules were dry. When dry, the capsules were collapsed, brown in color, and very brittle.

The three lots of material were analyzed by Mr. W. O. Richtmann, at that time pharmacognostical expert in this bureau. Those dried in the open air at room temperature and in the air-bath oven were found to contain normal amounts of total alkaloids. The lot dried in the atmosphere of CO_2 contained no aklaloids at all.

An attempt was made the following year to repeat this experiment.

Mr. Hood collected and dried two lots of capsules, one in contact with the air, the other in an atmosphere of CO_2. Unfortunately, however, the experiment was hardly a repetition. Some of the capsules had begun to desiccate before the experiment was set up. An accident occurred to the container holding the lot drying in CO_2 with the result that the material was exposed for some time to the air. The experiment, however, was carried through. On analysis by Mr. Richtmann the air-dried material was found to contain 0.064 percent crude morphine, those dried in CO_2, 0.032 percent crude morphine calculated on dry weight at about 60° C. When the modifying conditions just described are taken into account, the results obtained seem to confirm those of the first experiment.

From the evidence at hand, we believe ourselves justified in tentatively advancing the conclusion that morphine as such does not exist in the poppy but is formed from a mother substance present in the latex through the action of oxidases using the oxygen of the air. It seems quite probable that the mother substance consists of a complex molecule which, under the action of atmospheric oxygen wielded by oxidases, is split along a fairly well determined cleavage line with the result that a rather constant N-containing product having the constitution of the alkaloid morphine arises. Should the reaction occur under somewhat different conditions, it seems possible that the lines of cleavage might shift somewhat, giving a different proportional quantity among the many alkaloids obtained from the poppy. When oxygen is absent and presumably oxidase action also, cleavage, if it takes place at all, may take place along quite different lines with the result that no morphine appears. That other alkaloids are affected as well as morphine is shown by the entire absence of an alkaloidal reaction in the material dried in CO_2. A certain kind of analogy between this situation and that seen in glucosides which are split up through the action of enyzmes is strongly suggested.

Inasmuch as physiological opinion concerning the significance of alkaloids to the plants producing them has tended strongly toward the view that they are waste products of plant metabolism, it seemed desirable to carry the investigation further. Obviously morphine itself can hardly represent to the poppy plant an accumulation of N-containing waste products.

It could hardly be taken for granted, however, that all alkaloids stand in a like relation to the plant. Accordingly, belladonna plants

grown on the experimental farm of the Department at Arlington Farm, Va., were used as material for experimental study. This plant was chosen because of the absence of latex and because it is a fair representative of a large and much studied group of alkaloid-bearing plants. The roots, known to be rich in alkaloids, chiefly atropine, were dug in November, 1905, quickly and carefully washed, cut into transverse slices from 3 to 6 mm. thick and divided into two lots. It has been shown by Sievers[3] that there is a wide range of individual variation in alkaloidal content in belladonna. The chance for error from this source was reduced by dividing the slices of each root equally between the two lots.

One lot of 450 grams fresh weight was placed in a glass jar the mouth of which was closed except for holes to permit the escape of excess gas and water vapor. CO_2 was led from a tank through sulphuric acid, thence through a copper coil immersed in boiling water to give the gas a greater water-absorbing capacity and thence into the bottom of the jar containing the sliced roots. The jar itself stood in a water bath kept at boiling temperature from 9 a.m. to 4:30 p.m. while the gas flow was maintained throughout the day. The material was dry and hard on December 2.

A second lot was placed in a similar jar likewise heated in a water bath, but provided with a supply of air instead of CO_2. Drying was finished on November 29 when the material was hard and dry and had a pronounced odor of brown sugar.

Duplicate analyses of the powdered material made by Mr. W. O. Richtmann showed the following result:

Total Alkaloids in Belladonna Roots

Treatment	Sample	Total Alkaloids. Percent
Dried in CO_2 current...............	*A*	0.665
	B	0.665
Dried in air current................	*A*	0.642
	B	0.625

These data show clearly that the alkaloidal yield of belladonna root is not dependent on the action of oxygen and, therefore, is governed by physiological conditions quite different from those govern-

[3] Sievers, A. F. Individual variation in the alkaloidal content of belladonna plants. Journ. Agr. Research 1: 129–146. 1913.

ing the formation of morphine. The application of guaiac solution to the freshly cut root produced a very strong oxidase reaction, apparently most intense in the cortical regions. The addition of hydrogen peroxide did not markedly intensify the color.

As far as the evidence here submitted goes, the belladonna alkaloids exist ready formed in the plant perhaps as accumulated waste products.

Summary

In conclusion, the results here reported may be briefly summarized:

1. It appears from work done on the opium poppy, *Papaver somniferum*, that the oxidase reaction is most active in the upper parts of the plant, especially in the floral structures, capsules and actively growing parts. The peroxidase reaction shows less variation in its intensity in the different parts of the plant.

2. The intensity of the oxidase reaction roughly parallels the distribution of the latex which in itself is most active.

3. The oxidase seems to be either "used up" or otherwise inactivated during the course of its action. A like exhaustion or inactivation of the supposed enzyme was seen in the case of the oxidase of the Irish potato. These observations would indicate that perhaps the oxidase reaction is not due to a catalyzing agent, therefore is not due to an enzyme.

4. With exception of the root, the intensity of the oxidase reaction runs roughly parallel with the alkaloidal content. In the root, the alkaloid content is relatively higher than the intensity of the oxidase reaction.

5. Alkaloids seem not to exist as such in the poppy plant but to appear as products of the action of the oxidases on constituents present in the latex reacting in the presence of oxygen.

6. The alkaloids of *Atropa belladonna* differ from those of the poppy in that they are found to exist in structures dried without contact with free oxygen and seem to exist ready formed in the plant.

Office of Drug Plant, Poisonous Plant,
Physiological and Fermentation Investigations,
Bureau of Plant Industry, U. S. Department of Agriculture.

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Pinkroot and its Substitutions.

By W. W. STOCKBERGER.

MILWAUKEE,
Pharmaceutical Review Publishing Co.
1907.

Fig. 1. PINKROOT (SPIGELIA MARILANDICA L.).
Stockberger, Bulletin No. 100, Part V, Bureau of Plant Industry, U. S. Dept. of Agr.

Fig. 2. East Tennessee Pinkroot (Ruellia ciliosa Pursh).
Stockberger, Bulletin No. 100, Part V, Bureau of Plant Industry, U. S. Dept. of Agr.

Introduction.*

The object of this paper is to trace the beginning and development of the confusion concerning the drug known as pinkroot, which has made it possible for an entirely unrelated product of extremely doubtful efficiency to masquerade successfully before the drug expert as well as the drug dealer for many years as the genuine article and well nigh drive the latter out of commercial existence. A specific illustration is furnished of the possibilities of obtaining reliable results in revising and extending our knowledge of the authenticity and the sources of our crude drugs through their study under cultivation.

For the purposes of scientific experimentation on the action of drugs in health or in disease the absolute identity of the material used is obviously necessary. To secure the desired results in his practice, the physician must feel confidence in the source of the medicinal substances used. Crude drugs as they ordinarily occur in the market fail too frequently to fulfill this requirement through the confusion of the plants concerned or through the willful introduction of sophistications.

Hundreds of tons of crude drugs are produced and consumed annually in this country. Manifestly substitution or adulteration in this product is a standing menace to the public health. Yet, as this paper sets forth, plants of unknown und possibly deleterious proper-

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* This paper was prepared by Mr. W. W. Stockberger, Expert in Drug Plant Investigations in the laboratories of the Bureau of Plant Industry, U. S. Department of Agriculture. A brief synopsis of the subject matter of the paper was printed October 9, 1906, as Bulletin No. 100, Part V, of the Bureau of Plant Industry. The publication of the complete paper in the Pharmaceutical Review has been approved by the Honorable Secretary of Agriculture.

R. H. True, Physiologist in Charge.

Some time after this work was in manuscript Mr. Theo. Holm published an interesting article on the root structures of *Spigelia*, *Phlox*, and *Ruellia*, (Amer. Jour Pharm., Dec. 1906) in which he fully confirms the conclusions reached in this paper.

ties may so far replace an official drug plant as to be confused with the real drug and in its stead be made the basis of study and experiment.

Only through cultivation and by bringing the plants to maturity for exact identification was it possible to determine with certainty the interrelationship of the pinkroot, *Spigelia marilandica* L. (Fig. 1), and its adulterants, a method of procedure which recommends itself in all critical study of drug plants.

HISTORY.

FIRST DESCRIPTIONS OF THE PLANT SPIGELIA.

The plants known by the name of pinkroot, and widely famed for the anthelmintic virtues of which they were the reputed possessors, had long been known to botanists and described by them under various generic names before they were erected into the present genus Spigelia by Linnaeus. The species now known under the name *Spigelia anthelmia* L. was the first to be noticed and was described by Marcgraf [1] in 1648 and in his "Historiae Plantarum" under the name Arapabaca. The exact locality from which the plant was collected and described is not known, as he says simply "a plant called Arapabaca in Brazil." His account embraces merely a very brief botanical description, as is usual with the early authors. No statement of the distribution of Arapabaca or of its properties is given, but the description is supplemented by a very good colored plate which shows the general botanical characters of the plant and renders its identity certain.

In 1703 Plumier,[2] in describing new American plants, referred to and quoted Marcgraf's description of Arapabaca. He has been erroneously referred to by Periera and by Bonyun as the first author to mention the *Spigelia anthelmia*. The latter author perpetrates the error in an article the purpose of which was to establish the prior claims of *S. anthelmia* on the notice of the scientific world.

According to Bergius [3] a contemporaneous description of this

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1 Marcgraf, G. Historiae Rerum Naturalium Brasiliae. Historiae Plantarum. vol. 1, p. 34, 1648.
2 Plumier, C. Nova Plantarum Americanarum, Genera. p. 11. Paris 1703.
3 Bergius, P. J. Materia Medica e Regno Vegetabili. vol. 1, pp. 93—95. Stockholm, 1778.

plant was made by Hernandez[1] in his work on Mexican medicinal plants in 1651, where he describes under the name "Xivhtotonqui, seu herba calida Totopocensi" a plant to which he ascribes numerous remedial properties. Since no other author mentions this plant as synonymous with *Spigelia anthelmia*, and as Hernandez's figure of the plant is almost devoid of characters suggesting Spigelia, his description of its properties also including a number not possessed by that plant, we must regard the correlation of Bergius as very doubtful. At all events his description is antedated by that of Marcgraf.

Not far from the time when Plumier commemorated Marcgraf's name Arapabaca, another term was introduced by Petiver[2], who gave a short account of its botanical characters, and, because of the relationships of the plant as he understood them, called it *Heliotropium brasilicum*.

Amid the sweeping changes in nomenclature made by Linnaeus[3] in his Systema Naturae, Plumier's genus Arapabaca disappeared, and on it was founded the Linnaean genus Spigelia, so named in honor of Adrien von den Spieghel, a Flemish botanist, a professor at Padua, whose first work was published in 1606 and whose death occurred in 1625. It is stated in Woodville's Medical Botany[4] that the American species was first called Lonicera by Linnaeus, but that he afterwards ascertained its true characters and called it Spigelia in honor of Spigelius. This must refer to the addition of a new species, and not to the founding of the genus as the reading indicates, since, as just stated, the genus was founded in 1747, while the first mention of *Spigelia marilandica* occurred in 1767.

In 1751, writing in the Gentleman's Magazine, Browne[5] gives an account of the properties and use of a plant which he called Anthelmia. He says: "In some parts of the island of Jamaica grows a small plant, known in the Windward Islands by the name of *Worm-grass*, which I have taken the liberty of describing by the name of *Anthelmia*, as it was a genus not before known in botany." It appears that at the time this was written, Dr. Browne was not aware of the work of Marcgraf and of Linnaeus, by whom the genus was

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1 Hernandez, F. Rerum Medicarum Novae Hispaniae Thesaurus, p. 201, Rome, 651.
2 Petiver, James. Gazophylacii Naturae et Artis, etc. tab. 59, 1702—1709.
3 Linnaeus, C. Systema Naturae, ed. 2, p. 25, 1747.
4 Woodville and Hooker. Medical Botany, ed. 3, p. 179, 1832.
5 Browne, Patrick. Account of the Anthelmia. Gentleman's Magazine, 21 544—546, 1751.

founded, and that the same plant had been described by Büttner as "Spigelia, ramis indivisis, etc." Browne's description, however, is of interest because of the account of the medicinal properties and use of this plant. Two years later Linnaeus [1], in his Species Plantarum, described the first species of the genus Spigelia, and, recognizing that the Anthelmia of Browne was the same as the Arapabaca of Maregraf, gave it the specific name *anthelmia*, since which time the generally accepted name for the plant has been *Spigelia anthelmia* L.

In 1756 Browne [2] published an account of this species under the name *Anthelminthia quadriphylla*. The change in the generic name from the Anthelmia of his earlier account was made possibly to suggest more readily its anthelmintic properties. The Spigelias of Büttner and of Linnaeus were recognized as synonyms, as was also the Arapabaca of Maregraf and Plumier. It is stated that this plant grows naturally in most parts of South America and that it was cultivated in the gardens of Jamaica. Later observations on the flora of this island have shown that the plant is indigenous to Jamaica. In addition to the botanical description of the plant, an account of its use and medicinal properties is given.

The common names of this species are not without interest, and deserve mention here, since they reflect something of the history of the species and also suggest in several cases the properties which the plant is reputed to possess. Thus we have Arapabaca, Cunana, loggerhead weed; Demerara pinkroot, and West India pinkroot, suggesting locality; Brinvilliers, the term applied by the French, refers to its poisonous properties, while its medicinal properties are indicated by Spigelie anthelmintique, worm-grass, Yerba de Bombrices, Yerba de lombrices, poudre a vers, and Lombricera blanca.

In the year 1704, fifty-six years after Maregraf had described Arapabaca, John Ray [3] published the description of a new plant which afterwards became the second species in the genus Spigelia under the name *Spigelia marilandica*. The first botanical description of this plant as set forth by Ray in his Dendrologiae is as follows:

> "Periclymeni *Virginiani* flore coccineo planta *Marilandica* spicata erecta foliis conjugatis. D. Sherard."

[1] Linnæus, C. Species Plantarum, Vol. 1, p. 149, 1753.
[2] Browne, Patrick The Civil and Natural History of Jamaica, p. 156, London, 1756.
[3] Ray, John. Historiae Plantarum, vol. 3, Dendrologiae 3, No. 23, p. 32, London, 1704.

It is very probable that Ray received his specimens from Sherard and appended his name to the description as an acknowledgment of the source from which he obtained the plant, since there is no mention of Spigelia in the writings of Sherard. The plant had been under cultivation in England for some years prior to Ray's description, but there is no earlier reference to its systematic place by other authors.

Several facts of importance in the history of *Spigelia marilandica* are to be noted in the work of Catesby [1] on the Carolinas. In his description he assigns a new systematic place to the plant, as follows:

> *Gentiana* forte? quae Periclymeni Virginiani flore coccineo, etc.

Catesby cites the work of Ray just mentioned and is the first to give the common name by which the plant was known in its native habitat. This is stated to be the Indian pink, and a somewhat detailed description of the botanical characters of the plant and a good colored plate are features of the work. Concerning the cultivation of the plant Catesby further says: "This Plant was in Blossom, the First of August 1738, in the garden of Mr. Christ. Gray at Fulham, and endures the Winter without any Protection."

In an account of the flora of Virginia some years later Gronovius [2] gives this plant the name Lonicera, the name which was first used by Linnaeus. Under the *Pentandria monogynia* of Gronovius occurs this description:

> "*Lonicera* spicis terminalibus, foliis ovato-oblongis acuminatis distinctis sessilibus. Fl. Virg. 142."

The previous descriptions of Ray and Catesby are cited and regarded as synonymous. Simply the botanical description is given: there is no reference to distribution or properties.

In a letter written about 1751, Dr. John Lining [3] discusses the Indian pink and in his formula for its medicinal use refers to it as "Rad. Anthelmiæ (for so I called the Indian pink)."

In an abstract and summary of this letter in the Amœnitates Academicæ [4] this term is referred to and attention called to the fact

[1] Catesby, Mark. The Natural History of Carolina, Florida and the Bahama Islands, vol. 2, p. 78. London, 1743.
[2] Gronovius, D. Flora Virginica, ed. 2, p. 30, Leyden, 1762.
[3] Lining, J. Of the Anthelmintic Virtues of the Root of the Indian Pink. Essays and Observations Physical and Literary, vol. 1, Art. XIV, pp. 386—389. Edinburgh, 1754.
[4] Colliander, J. G. Spigelia Anthelmia. Amœnitates Academicæ 5: 133—147. 1758

that the Anthelmiæ of Lining is not the same as the Anthelmia of Browne. This point was further emphasized by Dr. Garden[1] a few years later in his letter to Dr. Hope, when in observation 2, after the description of the Indian pink, he says: "also the five-lobed calyx, the structure of the limb and anthers, the articulated style belonging to this, separate it from Spigelia." The Spigelia here referred to is the Anthelmia, or the Spigelia of Linnæus in the sense in which those terms were used by Browne[2].

The name Lonicera introduced by Gronovius was adopted by Linnæus[3], and appears in his Systema Naturæ as late as 1767. In the body of this work (ed. 12, p. 166) the plant is referred to as *Lonicera marilandica*. Later, however, after examining a specimen of the plant with fruit sent to him by Dr. Hope, he decided that it was a true Spigelia, and in the appendix to the same edition (p. 734) gives the name under which it is now known, *Spigelia marilandica*.

INTRODUCTION INTO EUROPE.

The time of the first introduction into Europe of the two Spigelias is somewhat obscure. Confused with the early botanical accounts of these plants are the references to the discovery of their medicinal properties, and thus there have arisen divergent statements concerning their early introduction and use.

Bobart[4] is said to have cultivated *Spigelia marilandica* in England in 1694. This was ten years before its first description botanically and nearly fifty years before observations on its medicinal properties were recorded by Europeans.

The earliest authentic date of the introduction of *Spigelia anthelmia* is that given in Johnson's Gardener's Dictionary[5]. Here it is stated that the *S. anthelmia* was introduced into cultivation in 1759. This was several years after attention had been called to the medicinal properties of the plant by Browne. Sprengel[6], in the chronological tables of his History of Medicine, assigns 1739 as the date for the introduction of *Spigelia marilandica* and *S. anthelmia*. His authority for this date is not mentioned, but it may have been inferred from

[1] Garden, A. An Account of the Indian Pink. Essays and Observations Physical and Literary, vol. 3, Art. X, pp. 145—153, 1771.
[2] Browne, P. Gentleman's Magazine, 21:544, 1751.
[3] Linnæus, C. Systema Naturæ, ed. 12, vol. 2, p. 166, 784, Stockholm, 1767.
[4] Alton, Wm. Hortus Kewensis, 1:202, London, 1789.
[5] Johnson's Gardener's Dictionary, p. 920, new ed., London, 1894.
[6] Sprengel, Kurt. Histoire de la médecine, 4:431, Paris, 1815.

Catesby's work, published in 1738. The earliest date assigned by the authorities cited in their historical accounts of each of these species [1] is 1748, the date mentioned by Browne for *S. anthelmia.*

From the records now available it appears that although the *Spigelia marilandica* was discovered and described much later than *S. anthelmia,* nevertheless it was introduced to cultivation in Europe about fifty years earlier.

DISCOVERY OF MEDICINAL PROPERTIES.

The anthelmintic properties of Spigelia had long been known and made use of by the native inhabitants of the West Indies, Central America, and the southern United States before Europeans came to a knowledge of its virtues. However, attention was early called to its efficacy in checking what threatened to become an epidemic of disorders among the slaves of the planters in the British colonies, due, as was supposed, to the presence of worms induced by the hardships, coarse diet, and irregular habits of living of the slaves. Dr. Browne [2] states that in 1748 these disorders reached such a height as to threaten the ruin of many of the planters by the loss of their slaves. He introduced the *Spigelia anthelmia* in his practice at that time and after observing its good effects in curing many cases which it was feared would terminate fatally, he was so impressed with the value of the plant medicinally that he felt constrained to make public its description, effects and the manner of its use. Hughes [3], whose work appeared a year earlier than that of Dr. Browne, also refers to the early use of this plant and commends it as a powerful anthelmintic.

The earliest mention of the vermifuge virtues of *Spigelia marilandica* is that made by Catesby [4] in 1743. After describing this plant, which he calls the Indian pink, he says: "A Decoction made of this Plant is good against Worms." It seems to have been known to the medical profession and in general use as a domestic remedy for a long time prior to the publication of Catesby's work, for in a letter written by Dr. Lining [5], of Charleston, S. C., to Dr. Whytt, in 1754, it is stated that: "It has been for many years used in this part of the

[1] Sprengel, l. c., 5:494—495.
[2] Browne, P. Gentleman's Magazine, l. c., 1751.
[3] Hughes, G. The Natural History of Barbadoes, p. 230, 1750.
[4] Catesby, M. The Natural History of Carolina, vol. 2, p. 78, London, 1743.
[5] Lining, J. Essays and Observations Physical and Literary, 1:386. Edinburgh, 1754.

world, not only by all the practitioners but likewise universally by the planters." Another Charleston physician, Dr. Garden [1], in his first letter to Dr. Hope, which was written about 1763, says: "About forty years ago the anthelmintic virtues of the root of this plant were discovered by the Indians, since which time it has been much used by physicians, practitioners, and planters." From this it appears that the Indians communicated a knowledge of its properties to the whites about 1723. How long they had possessed this knowledge can not be determined, but evidently they had used the plant long enough to have a very high regard for its virtues, for according to Barton [2] "The Cherokee Indians have so high an opinion of this plant, that it would sometimes be dangerous for a person to be detected digging it up, to carry it out of the country."

By the letters of Lining and Garden, the medicinal properties of *Spigelia marilandica* were widely exploited in Europe, about 1754, and, largely on the authority of these practitioners, who reported such excellent results attending its use, it was admitted to the London Pharmacopœia in 1788.

EARLY CONFUSION OF SPIGELIA ANTHELMIA AND SPIGELIA MARILANDICA.

The almost simultaneous introduction into Europe of *Spigelia anthelmia* and *S. marilandica* as anthelmintics caused them to be frequently mistaken one for the other. No doubt Dr. Lining was acquainted with the account of the Jamaica species by Dr. Browne, for in his writing on the one used in the Carolinas he designated it as Anthelmia, the same term Dr. Browne had used in describing the former. This similarity of name may account for the confusion with regard to which of the plants Brocklesby [3] used so successfully in his practice. Writing at London in 1764 he says: "In some cases * * * [of worms] I had recourse to the Anthelmia or Indian Pink * * *". He was so impressed with its virtues that he recommended it to the Faculty of London and says further: "Dr. Hinckley, one of the physicians to Guy's hospital, has prosecuted farther experiments with this plant, which he calls Caryophyllum Americanum Anthelminticum."

[1] Garden, A. Essays and Observations Physical and Literary, 3:145—153, 1771.

[2] Barton, B. S. Collections for an Essay towards a Materia Medica, p. 38, ed. 3, 1810.

[3] Brocklesby, Richard. Oeconomical and Medical Observations, p. 282, London, 1764.

He credits Dr Lining as being the first medical writer that he has known to mention the anthelmintic virtues of the root. He was evidently not acquainted with the writings of Catesby previously cited. A number of medical writers, among whom are Sprengel, Woodville, and Murray, probably influenced by the use of the name Anthelmia, cite the statements made by Brocklesby as confirming the virtues of *Spigelia anthelmia*, but a careful reading of his text discloses no reference to that species. On the other hand, his use of the term "Indian pink," the reference to Dr. Lining's work, and the name given by Hinckley are evidence that he used the *Spigelia marilandica*, and to this species his observations should be credited.

From the name proposed by Hinckley for this species may have originated the term *Radix caryophyllae*, sometimes erroneously used in dealers' lists to denote *Spigelia marilandica*.

Another element of confusion between these two species was introduced in 1823 when Feneulle[1] published a chemical analysis of what was supposed by him to be *Spigelia anthelmia*, an analysis which the dictum of later years accords to *S. marilandica*.

Feneulle's description of the roots used in his analysis furnishes one of the strongest evidences that he had *Spigelia marilandica*. He says: "Leur coleur est braune; elles ont une odeur aromatique peu marquée; leur saveur est amère, mais plus décidément astringente." Another consideration is his reference to the United States as the place where its use originated, as follows: "La spigélie est la *Spigelia anthelmia* de Linné, il paraît que c'est aux Etas-Unis où on a commencé à l'employer." Madiana[2], who had traveled extensively in North America, never saw *Spigelia anthelmia* growing or in the collections in the shops. He states that *Spigelia marilandica* is the only species used in the United States, that the commerce of America only furnishes a product with roots, stem, leaves, and flowers, which are the subject of the work of Feneulle. He further states that *Spigelia anthelmia* is not exported to Europe except perhaps in the form of a sirup which is bottled by the negresses of the West Indies, and that it keeps badly and is not in good repute with the medical practitioners of the Continent.

[1] Feneulle, H. Analyse de la Spigélie anthelminthique. Journal de Pharmacie et des Sciences Accessoires, 9:197, 1823.

[2] Ricord-Madiana, J. B. Recherches et Expériences sur les Poisons d'Amérique. 1er Mémoir Du-Brinvilliers, Bordeaux, 1826.

Later times have brought the confusion of unrelated plants with *Spigelia marilandica* through their introduction as adulterants. How one of these, *Ruellia ciliosa* Pursh, has been figured and described as Spigelia itself, and how Ruellia in turn has been mistaken for *Phlox ovata* L. (*Phlox carolina* L.) and so described and figured as an adulterant of Spigelia, will be fully discussed later.

CHEMICAL RESEARCHES.

The first chemical study of *Spigelia anthelmia* was made by Ricord-Madiana[1] in 1826. That he had a plant different from the one investigated by Feneulle appears from his statement of the appearance and properties of the roots, which were branched and hairy, covered with a brown epidermis, white inside, and of a repellant odor. The fresh root was not found to be bitter, acrid, and astringent as was observed by Feneulle in the Spigelia examined by him.

The methods used by Madiana were the same as those employed by Feneulle. All parts of the plant were subjected to analysis and he determined in the leaves and in the root the following constituents:

> *Leaves:* Chlorophyll, volatile oil, abundant mucus, wax, stearin, gallic acid, a black gummy mass not bitter but nauseous, lignin, malates of potassium, lime, and other mineral salts.
>
> *Roots:* Fat, stearin, wax, resin in very small amount, mucus, albumin, gallic acid, carbonate and chloride of potassium; sulphate, subcarbonate, and phosphate of lime; oxid of iron, silicia, lignin.

Madiana notes especially the absence of a volatile oil and of a bitter substance in which according to Feneulle the vermifuge action resided.

Recently, in 1896, Boorsma[2] made a careful study of *Spigelia anthelmia* in search of an active principle which would account for its toxic effects. He succeeded in isolating an alkaloid resembling in its action gelsemine and strychnine.

In isolating the alkaloids Boorsma first sought for a volatile active principle by distilling a mass of fresh herb and shaking out the distillate with ether. After evaporation of the ether extract the resi-

[1] Ricord-Madiana, l. c.

[2] Boorsma, W. G. Nadere Resultaten van het door Dr. W. G. Boorsma verrichte Onderzoek naar de plantenstoffen. Mededeelingen uit Buitenzorg's lands Plantentuin, XVIII, 1896.

due consisted in part of feathery crystals soluble in acidulated water and having a feeble reaction to the common alkaloidal reagents, but possessing practically no poisonous properties. The liquid remaining after the separation of the ether extract was acidulated and evaporated to a small residue. This gave absolutely no alkaloid reactions and also was not found to be poisonous. Boorsma therefore concluded that the plant does not contain a volatile alkaloid.

In his research for fixed alkaloids Boorsma used alcoholic extracts of the fresh plant which were partially soluble in water acidulated with acetic acid. The aqueous solution was then purified with basic lead acetate, concentrated by evaporation and shaken up with chloroform so long as it would take anything from the alcohol. The chloroform extraction was much more perfect when the solution was made alkaline with ammonia. After evaporation the chloroform left a brownish sticky residue, intensely bitter to the taste and largely though not entirely soluble in acidulated water. It is insoluble in pure water, ether, carbon disulphid, and petroleum ether.

Solutions of the alkaloid were not found to be very sensitive to the general alkaloidal reagents. In a concentration of 1 per cent. only a slight cloudiness appeared. More abundant precipitates were obtained by the use of iodin potassium iodid, and phosphotungstic acid. It has no very distinctive color reactions. Nitric acid dissolves the alkaloid with the development of a yellow color. Sulphuric acid with cerium oxid gives a dirty brown coloration, as does also Fröhde's reagent and sulphuric acid.

The alkaloid was extremely bitter, and physiological tests showed that it possessed remarkable toxic properties. On frogs it produced not tetanic but spinal paralysis. The hypodermic injection of 0.5 mg. was found to be lethal to guinea pigs.

As Dudley had already used the term "spigeline" to designate the new volatile alkaloid isolated by him from *Spigelia marilandica*, Boorsma proposed for the alkaloid isolated by him from *Spigelia anthelmia* the name "spigeliine."

Within recent years another species of Spigelia has attained a place in the Mexican Materia Medica [1]. This is *Spigelia longiflora* Mart. & Gale, known to the natives as "sangre de Toro" and "Yerba

1 Nueva Farmacopea Mexicana, ed. 3, p. 94, 1896.

del burro." It is used medicinally as a succedaneum for *S. anthelmia*. Cordero[1] has studied the chemistry of the plant and finds a volatile alkaloid by the same methods used by Schloessing in isolating nicotine and by Dudley in obtaining "spigeline." A very small quantity of the plant extract proved very poisonous to animals. Its extremely poisonous properties have prevented the collection of any positive data as to its value as an anthelmintic. It is believed that the risks attending its use as such are not compensated by the possible good effects to be obtained.

Spigelia marilandica has been the subject of several chemical researches, the first of which was made by Feneulle in 1823. Wackenroder[2], Stabler[3], Dudley[4], and Boynton[5] have also made proximate analyses of this plant, but their results are discordant and their work on the whole yields but an imperfect knowledge of its chemical properties. A somewhat detailed account of these researches is given later in the account of the true pinkroot.

ORIGIN OF TRADE VARIETIES OF PINKROOT.

The species of pinkroot (*Spigelia anthelmia*) which early attained great repute as a domestic medicine among the natives and laborers of British Guiana, particularly along the east and west coasts of Demerara and on the banks of the rivers there, received the name Demerara pinkroot, a term which is yet frequently used when it is desired to distinguish this species from the pinkroot occurring in the United States. Mention is made of this species by Bonyun[6], who states that in preparing this plant for sale it is pulled up by the roots in a green state and the seeds stripped off, and then it is carefully cleaned, dried in the sun, and packed in bundles.

The variable and sometimes poisonous action of the *Spigelia marilandica* has frequently been attributed not to the presence of harmful substances in the plant itself, but to its admixture or adulteration with other roots possessing deleterious properties. In 1819 Ewell[7], after reciting a case in which the use of the Carolina pinkroot had been followed by an affection of the eyes, says: "Then use

[1] Datos para la Materia Medica Mexicana, part I, p. 251, 1894.
[2] Wackenroder, H. G. F. De Anthelminthicis, p. 52, 1826.
[3] Stabler, R. H. On Spigelia. Proc. Amer. Pharm. Assoc., 6:132—134, 1857.
[4] Dudly, W. L. Preliminary Notice of a New Volatile Alkaloid. Amer. Chem. Jour., 1:154—155, 1879—80.
[5] Boynton, W. C. Laboratory Notes. Amer. Jour. Pharm., 56:570, 1884.
[6] Bonyun. On Spigelia Anthelmia. Pharm. Jour., 5:354—355, 1846
[7] Ewell, James. The Medical Companion, p. 605, 1819.

the tops only, as it is supposed the deleterious effects are in consequence of some other root being attached to it." After discussing the probability of the Carolina pinkroot possessing poisonous properties, Kost [1] says: "It is also remarked that all the bad effects that have been observed in the use of this article have been caused by another plant which is inadvertently or fraudulently collected and sold mixed with the spigelia." It is thus evident that the idea was early prevalent and growing that much of the so-called Carolina pinkroot for sale in the drug markets was adulterated with some other plant of unknown origin.

A tacit admission of the substitution of some plant with unknown but probably harmful properties is made by Brown [2], when on prescribing a tincture of pinkroot in a worm mixture he says: "Be cautious to get *good* pinkroot, as much of the plant sold for pinkroot by the druggists is poisonous." In the early sixties it was observed that the invoices of pinkroot received from Tennesse were composed largely of an unknown root which was recognized as differing essentially from Spigelia. So persistently was this root offered as pinkroot by the collectors of Tennessee that it soon formed a trade variety which was indicated by the name Tennessee pinkroot or East Tennessee pinkroot, a term which is still in use by dealers in crude drugs.

The late Professor Maisch [3] stated in 1883 that the Spigelia which was commonly sold twenty-five years before had entirely disappeared from the market and that its place had been taken by the much smaller roots of *Spigelia marilandica* and by one or more species of Phlox. Some have inferred from this change in the appearance in the crude drug that *Spigelia anthelmia* was first used in the United States and was afterwards supplanted by *Spigelia marilandica*. That this was not the case becomes evident when it is noted that *Spigelia anthelmia* was not known in the United States, that it was not an article of commerce, and that clear evidence of the knowledge and use of the *Spigelia marilandica* is afforded by the writings of Garden, Lining, and others.

When the source of supply from the Southern States was cut off by the civil war it is not improbable that the major part of the market supply at the north was obtained from Tennessee, and since the roots

[1] Kost, J. The Elements of Materia Medica and Therapeutics, p. 355, 1858.
[2] Brown, O. Phelps. The Complete Herbalist, p. 195, 1867
[3] Amer. Jour. Pharm., 55:631, 1883.

of robust specimens of East Tennessee pinkroot are larger than those of Spigelia, Profesor Maisch may have had material from that source in mind when he referred to the size of the roots.

THEORY THAT THE CAROLINA PHLOX WAS AN ADULTERANT.

Responsibility for the probably erroneous statement that species of Phlox, particularly *Phlox ovata* L. (*Phlox carolina* L.), were substituted for Spigelia can not be fixed with certainty. The Wallace Brothers, of Statesville, N. C., are said to have identified the East Tennessee pinkroot under the above name. Professor Hyams claimed that he had made a similar identification for which he had not received due credit. Maisch had in his collection samples labeled in a manner indicating that he believed them to be Phlox. Recent investigations, however, show quite clearly that *Phlox ovata* does not occur as a substitute for Spigelia. This subject is discussed in some detail under the head "Minor Adulterants of Spigelia," and the botanical source of the false pinkroot is shown to be a species of Ruellia in the discussion of "East Tennessee Pinkroot."

ANATOMICAL STUDIES.

The plant family *Loganiaceae* to which the Spigelias belong, has been the subject of numerous and extensive researches. The Spigelias, however, have been much less studied than other allied genera, as *Strychnos*, for example, and then frequently only as accessory to some other work. The formation of internal phloem in the *Loganiaceae* was pointed out in 1875 by Vesque [1], but he laid small stress on this phase of his observations. He states that this tissue is composed of bast parenchyma and very large sieve tubes extending far into the pith. Hérail [2] devoted a large part of his research on the anatomy of the stem of dicotyledons to the internal phloem, for which he proposed the name "liber médullaire," for he believed that it was always medullary in origin. With respect to the *Loganiaceae* he says that the normal phloem is always much reduced, not to say wanting, in certain species. Outside of this occurs the pericycle forming a band composed of numerous layers of cells. Those of the exterior are

[1] Vesque, J. Mémoire sur l'Anatomie Comparé de l'Écorce. Ann. Sci. Nat. Bot., sér. 6, 2:82—198, 1875.
[2] Hérail, J. Recherches sur l'Anatomie Comparée de la Tige des Dicotylédones Ann. Sci. Nat. Bot., sér. 7, 2:203—314, 1885.

sclerified and form a ring of sclerenchyma which has been described as a character distinctive of plants of this family.

Perrot[1] suggested the term "perimedullary sieve tissue" for the anomalous tissue occurring around the pith in the *Loganiaceae*. He cites the well-known fact that this tissue is not always continuous around the pith, but occurs often in large isolated masses. In some tribes of the *Loganiaceae* it is lacking. These isolated masses increase in size by division of the cells on the exterior face while the oldest cells press toward the center. The most important works concerning the anatomy of the other tissues of the *Loganiaceae*, as well as an account of his own researches in the same family, are well set forth in the writings of Solereder[2], who examined in detail the structures of the different organs of representative plants of this family.

The anatomy of a number of species of Spigelia has been presented recently by Morelle[3]. He has considered the genus in five subdivisions, following Progel[4], and gives detailed accounts of the anatomy of eighteen species. Two of the species described, *Spigelia marilandica* and *S. anthelmia*, are of especial interest. In the observations on the former, however, undue emphasis has been laid on the so-called lateral wings of the stem. Commonly these are quite inconspicuous and occur prominently only in the vicinity of the leaf bases. The term "somewhat four-angled" better describes the usual condition of the stem. His figure showing the medulla of the stem gives an incorrect idea of the structure, the attempt to represent a resorbed condition of the pith having resulted in the appearance of large air spaces between plates of spongy parenchyma. The parenchymatous cortex is likewise normally much thicker than he has represented it, and he has not mentioned the occurrence of starch in the cortex and pith of the rhizome and in the cortex of the root, a very characteristic feature of *S. marilandica*.

With the exception of the wood his figure of the stem of *Spigelia anthelmia* closely resembles the structures usually occurring in the stem of *S. marilandica*.

[1] Perrot. Le Tissue Criblé. Thèse Agrég. École Pharmacie, pp. 161—173 Paris, 1899.

[2] Solereder, H. Ueber systematischen Werth der Holzstructur. Inaug. Diss. München, 1885; Systematische Anatomie der Dicotyledonen, p. 696, Stuttgart, 1899.

[3] Morelle, E. Histologie comparée des Gelsémiées et Spigéliées, pp. 50—95 Thèse, Paris, 1904.

[4] Progel, in Martius's Flora Brasil, vol. 6, p. 248, 1868.

Summing up the general characters of the genus, Morelle finds the stem possessing a peridem only in the perennial species. Sometimes the cortex includes large isolated sclerenchyma cells; sometimes it is wholly transformed into palisade parenchyma except at the angles of the stem where it is sclerified. The pericycle is frequently heterogeneous and thick, composed of fibers oval in cross section and slightly lignified intermingled with parenchymatous cells. The phloem is always very narrow, forming a continuous band. The woody portion is more or less thick. The medullary rays with rare exception have but one row of sclerified cells. Morelle finds that the pith is usually resorbed, sometimes persistent, and inclosing large isolated sclerenchymatous cells. The root structure is simple and the cortex abundant and starch-bearing. The center is occupied by the large woody portion, which is entirely lignified and contains numerous vessels.

The histological characters of *Spigelia longiflora* Mart. have been given by Cordero [1] and accord very closely with those worked out for other species. He notes that in the rhizome the medullary rays can not be distinguished, and states that the endodermis consists of two rows of regular cells, a point worthy of note since in all the other species of Spigelia in which the endodermis has been described it has consisted of one row of cells.

CONFUSED STATE OF KNOWLEDGE REGARDING PINKROOT.

The literature of pinkroot is sufficiently extensive and the experiments and observations upon it numerous enough to have established a considerable fund of accurate and definite knowledge concerning the nature and activity of the drug. Nevertheless, very little is actually known. Widely divergent opinions of its physiological properties are extant, the variability in results attending its use is unexplained, clinical observations are difficult to harmonize, the possession of poisonous properties is an open question, and wide divergence and nonagreement exists among those who have studied the plant chemically.

The recognition of an adulterant which frequently totally replaces the true pinkroot would naturally cause it to be prescribed with reluctance, since the administrations of preparations composed wholly

[1] Cordero, M. Datos para la Materia Medica Mexicana, part 1, p. 251, 1894.

or in part of the false pinkroot, the properties of which were unknown, might be followed by serious and unexpected results.

As will be shown later in this paper, studies purporting to have been made upon the structure and the chemistry of Spigelia have in reality been based upon some other plant mistaken for it. A striking example of the manner in which these errors are propagated is afforded by Schneider's work on powdered drugs [1]. As characteristic structures of Spigelia he describes and figures collenchyma cells, sclerenchyma cells, and cystoliths, and in his analytical key separates Spigelia by its lack of starch! Now the presence of starch is a prominent feature in Spigelia, while the structures just mentioned can not be found in *Spigelia marilandica*, but are characteristic of Ruellia.

Because of the failure of those who have made clinical observations on the effect of the pinkroot to determine absolutely the identity of their material, the question arises as to the validity of these observations, and it is not improbable that the properties ascribed to Spigelia may not be possessed by this plant but belong rather to the adulterant.

THE TRUE PINKROOT.

(*Spigelia marilandica* L., Syst. Veg. 197.)

SYNONYMS.

Spigelia oppositifolia Stokes, Bot. Mat. Med. I, 309.
Spigelia americana Monro., Med. Pharm. Chym. III, 270.
Lonicera marilandica Linn., Sp. Pl., Ed. 3, 249.
Periclymeni virginiana Raii., Dend. 32.
Spigelia lonicera Mill., Dict. V. 2.
Gentiana forte? quae Periclymeni, Catesby, Carol. II, 78, t. 78.
Anthelmia, Lining, Ess. and Obs. Phys. and Lit., I, III.

COMMON NAMES.

The common names under which *Spigelia marilandica* L. is known are numerous, and may refer to the vivid appearance of the plant, as pinkroot, starbloom, or to the locality and appearance combined, as Carolina pink, Carolina pinkroot, Maryland pinkroot, Georgia pinkroot, common pinkroot. Its medicinal use is indicated in the terms worngrass, perenniel worngrass, wormweed, wormroot, or American wormroot, wormseed, Maryland wormgrass. The use of it by the Indians accounts for such names as Indian pink, India pink, Indian plant, Indian pinkroot, and "unsteetla," a name used by the Cherokee Indians. It is also designated as snakeroot (a name applied to at least a dozen different plants, Lonicera, serpentine (La.), and arapabaca. By German authors it is called Nordamerikanischer Spigelie, Marylandisches Wurmkraut, Marylandische Spigelie, Gegenblatt spigelie, and Indianischer Pink. French writers frequently use the names spigélie du Maryland, spigélie officinale, œillet de la Caroline, racine d'œillet, and herbe des vers. Pinkroot is the name most commonly used, and the term "true pinkroot" serves to distinguish *Spigelia marilandica* (Fig. 1) from the plant widely substituted for it and known as "East Tennessee pinkroot" (Fig. 2).

BOTANICAL DESCRIPTION.

This plant (*Spigelia marilandica* L.), belonging to the family *Loganiaceae*, is an herbaceous perennial, which, springing up from a wrinkled and knotty rootstock, attains a height of from six to eighteen inches. The stem is erect and of a purplish color, obscurely four-angled above, glabrous or nearly so, and simple or branched at the base. The leaves are from two to four inches long, one-half to two inches wide, entire, sessile, and ovate or ovate-lanceolate in shape.

[1] Schneider, A. Powdered Vegetable Drugs, pp. 297—298. 1902.

They are of a rich dark-green color, membraneous, pinnately veined, oppositely situated on the stem with their bases connected by a stipular line.

The flowers are large and showy and are borne in a solitary one-sided terminal spike. The narrow tubular corolla gradually swelling toward the middle is from one to two inches long, of a scarlet color outside, and is divided at the summit into five linear spreading lobes which are yellow on the inside. The stamens are five, inserted on the corolla. The anthers and the round slender style are exserted. The two-celled capsule consists of two nearly equal and somewhat flattened segments. The seeds are shield-shaped and few in number, ripening in midsummer.

Distribution and Habitat.

The area of country over which *Spigelia marilandica* is distributed is quite large, but in much of the region its occurrence is not more than occasional. It is said to grow in rich open woods and copses from New Jersey to Wisconsin, Missouri, and Arkansas, south to Florida and the Gulf to Texas. North of Virginia the plant is rarely found. It is not mentioned in recent floras of New Jersey and Pennsylvania, and three localities only are known in Ohio, one in Indiana, and several in southern Illinois. In the Southern States, aside from North Carolina where it is not a common plant though to be found in the low and middle districts of the State, Spigelia occurs scattered through the rich valleys and prairies from the Atlantic to Texas. It is abundant in Tennessee, Georgia, South Carolina, Alabama, and Louisiana, and from localities in these and other Southern States the largest collections for drug purposes are made.

The plant is hardy and has been successfully cultivated in England as well as in the United States. It grows best in a moist boggy or peaty soil and does well usually in situations favorable for the members of the Heath family.

Description of Rhizome and Roots.

The rhizome of *Spigelia marilandica* (Fig. 3) is horizontal, sometimes bent and becoming erect, from one-half to two inches long, somewhat thicker than broad, knotty and wrinkled, dark purplish-brown in color. The frequent branches are short and knob-like. On the upper side are numerous cup-shaped scars where the former annual stems have broken away, and from the lower side spring many thin light-colored roots. Material collected in late summer or autumn shows the buds for the next year's stems. These are from one-fourth to one inch long, sealy, and of a deep brownish-purple color. In the dry condition the rhizome breaks readily, is hollow when the pith is reabsorbed, and shows an oval cross section. The fractured surface shows an outer ring of a dull-white color, within which is a ring of

yellowish wood. When the pith is present it is of a dull-white color and is usually full of starch.

The roots are fibrous, branching, and brownish-yellow in color. They are very brittle when dry, the broken surface showing a central

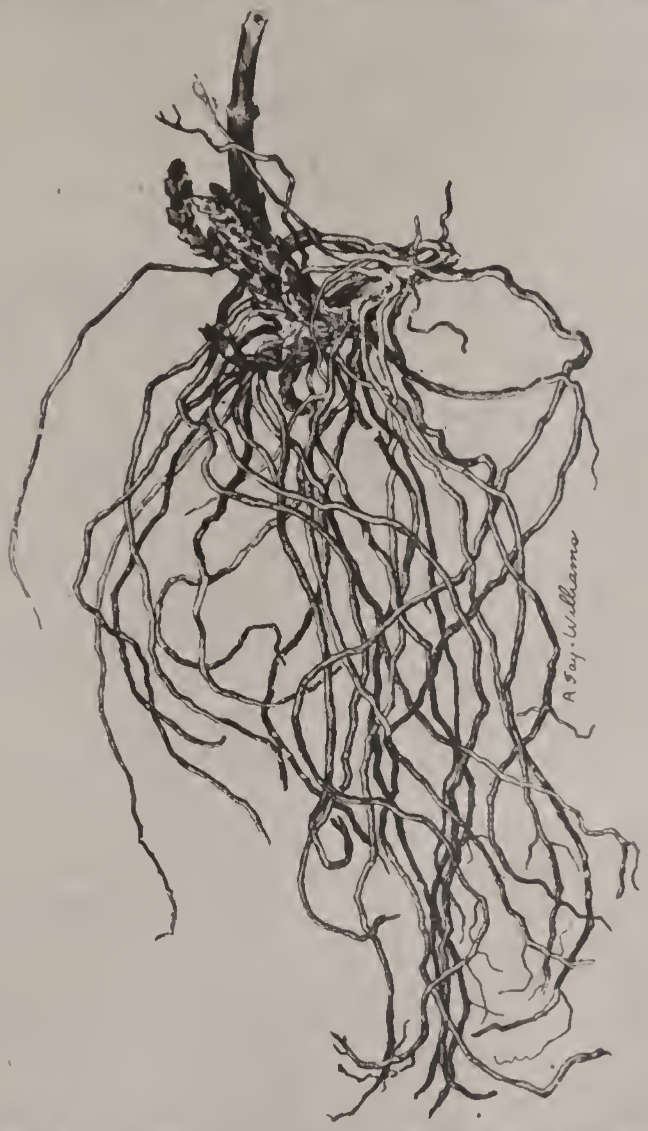

Fig. 3. Rhizome and roots of *Spigelia marilandica* L.

This figure shows the commercial appearance. The root system is often much more fibrous and branching.

wood of light-yellow color, surrounded by a ring of dull-white tissue loaded with starch.

The odor of the drug is slightly aromatic, the taste mildly bitter and pungent. These properties vary, however, with the situation in which it is grown and the time of gathering.

Anatomy.

The material upon which the study of the anatomy was largely based was obtained from plants of *Spigelia marilandica* secured from Mr. S. O. Barnes, of Bridgeport, Ala., in May, 1902, and kept under observation on the experiment drug farm of the Department of Agriculture on the Potomac Flats at Washington, D. C., until flowering established their identity beyond doubt. All essential details of structure have been verified in specimens from the United States National Herbarium and from a wide range of commercial samples of pinkroot after careful microscopical examination had demonstrated that they were composed of authentic material.

The sections here described and figured were cut from fully mature plants after flowering, those of the stem from its lower portion midway between nodes, those of the root about 2 cm. from its attachment to the rhizome.

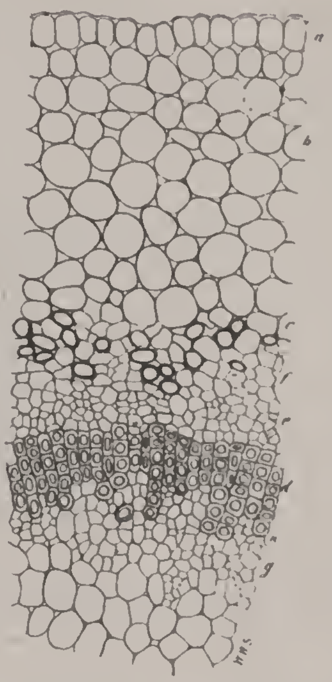

Fig. 4. Cross section of the stem of *Spigelia marilandica* L.

a, epidermis; *b*, parenchymatous cortex; *c*, bast fibers; *d*, xylem; *e*, cambium; *f*, external phloem; *g*, internal phloem; *h*, spiral vessels; *i*, pith cells. ×150.

Anatomy of the stem. In the young stem there is a normal ring of bicollateral leaf-trace bundles which develop laterally until in the mature plant a perfect ring of xylem is formed. The center of the stele is occupied by a pith which is composed of large, thick-walled parenchyma cells hexagonal in cross section and measuring from 30 μ to 75 in diameter. Around the pith and limited by the xylem is a layer of internal phloem in which sieve cells and companion cells may be distinguished in longitudinal sections. In cross section (Fig. 4) they can rarely be observed. Large spiral vessels appear as

projections toward the pith on the inner portion of the xylem ring; the remaining xylem consists of pitted cells 10 µ to 30 µ in diameter and 90 µ to 165 µ long. Around the xylem ring is a few-celled layer of cambium, which is in turn surrounded by the external phloem, in which sieve cells and companion cells may be clearly distinguished.

In the outer zone of phloem occur large, relatively thin-walled bast fibers, elliptical in cross section and from 15 µ to 25 µ in diameter along the longer axis. The cortex is composed of large, relatively thick-walled parenchymatous cells elliptical in cross section, measuring from 20 µ to 50 µ in diameter and from 70 µ to 155 µ in length. Between these cells occur large irregular intercellulars.

The epidermal cells very much resemble in cross section the cells of the cortex, but they are somewhat smaller. The length of the epidermal cells is approximately the same as the diameter in cross sec-

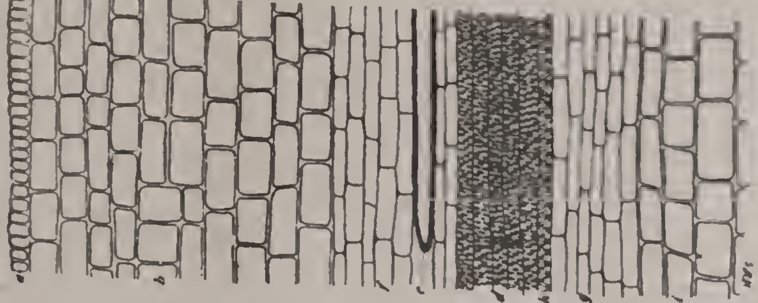

Fig. 5. Longitudinal section of the stem of *Spigelia marilandica* L. Letters signify as in fig. 4. × 150.

tion, the cells being nearly uniaxial. In longitudinal section (Fig. 5) usually four epidermal cells are in contact with a single cortex cell along its major axis.

Anatomy of the rhizome. The rhizome has a large central pith composed of parenchyma cells smaller in size and of less regular outline in cross section (Fig. 6) than those in the pith of the stem and the root. These cells are from 15 µ to 35 µ in diameter and from 30 µ to 90 µ long in the axis parallel to that of the rhizome. All the pith cells are loaded with starch grains.

The fibrovascular bundles are of the bicollateral type similar to those of the stem. There is present an internal phloem which occurs as a several-celled layer between the pith parenchyma and the wood. The xylem has a few spiral vessels on the side toward the pith, the

remaining tissue being composed of pitted cells 15 μ to 25 μ in diameter and from 75 μ to 135 μ in length. Lying without the xylem is a few-celled layer of cambium, beyond which is the external phloem, limited by a layer of cells, in appearance somewhat differentiated from the adjacent tissue, but not forming a distinct pericycle. The walls of these cells show but a slight thickening and the cells are devoid of starch content.

In the endodermis the characteristic thickening where the cell walls are in contact is evident even in young material in both cross and longitudinal sections (Figs. 6 and 7). These cells are more elliptical than those of the cortex, being compressed along the radial axis. No starch is present.

The large parenchyma cells of the cortex are irregular in size and conform to the prismatic type. Intercellulars occur throughout the cortex, but only sparingly in the outer layers. The radial axis of the cells is commonly the shortest. All the cells of the cortex are usually rich in starch. The cells of the epidermis are uniaxial and uniformly smaller than those of the cortex. They are devoid of starch and are thickened on the outer wall.

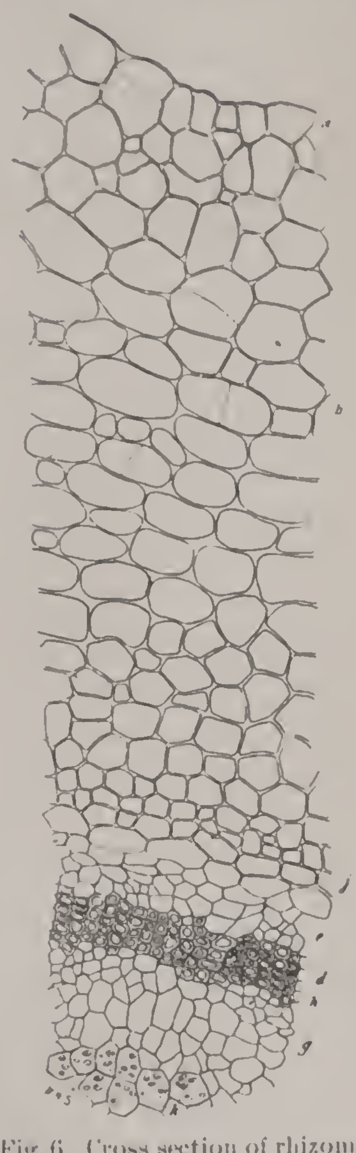

Fig. 6. Cross section of rhizome of *Spigelia marilandica* L.
a, epidermis; b, cortex; d, xylem; c, cambium; g, internal phloem; h, spiral vessels; j, endodermis; k, starch. × 150.

Anatomy of the root. The study of the root structures here described was made upon specimens from mature plants in the second year of growth taken just after the close of the flowering season. The larger roots had a maximum diameter of approximately 2 mm. and exhibited all the gradations in size usual in roots of fibrous type.

The epidermis consists of a single layer of nearly uniaxial cells with a thickened outside wall resembling a cuticle, sometimes staining as intensely as the xylem. The diameter ranges from 25 μ to 36 μ, varying in different cells and with different axes in the same cell.

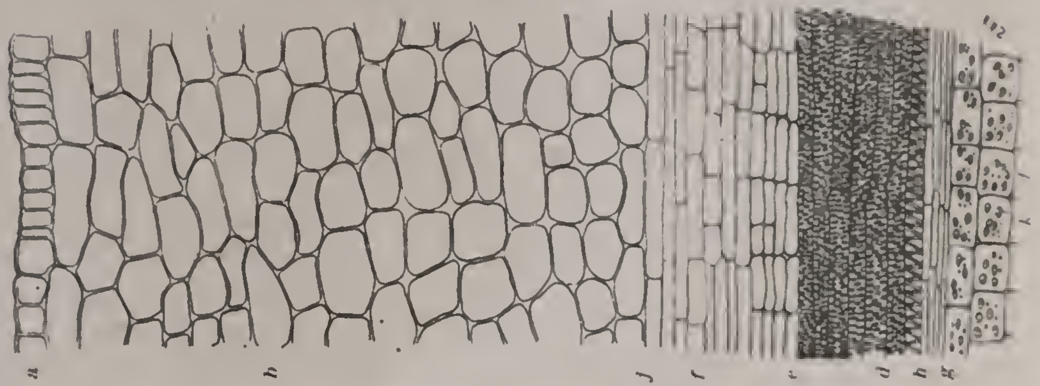

Fig. 7. Longitudinal section of rhizome of *Spigelia marilandica* L.
The rhizome here figured was not the same as the one shown in fig. 4. *a*, epidermis *b*, cortex; *d*, xylem; *e*, cambium; *f*, external phloem; *g*, internal phloem; *h*, spiral vessel; *i*, pith; *j*, endodermis; *k*, starch. × 150.

Many of the cells exhibit a nucleated protoplasmic content which stains intensely. No starch grains were observed in the epidermal cells.

The cortex consists of large parenchymatous cells, 30 μ to 70 μ in diameter and from 110 μ to 140 μ long. In longitudinal section

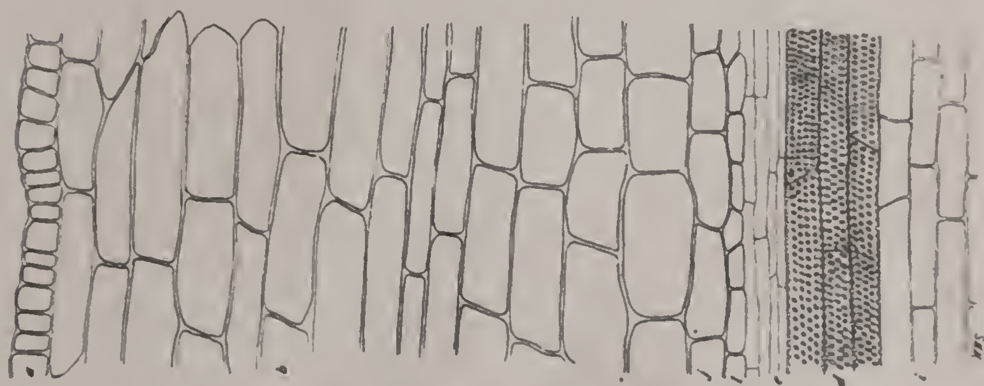

Fig. 8. Longitudinal section of root of *Spigelia marilandica* L.
a, epidermis; *b*, cortex; *d*, xylem; *e*, cambium; *i*, pith; *j*, endodermis; *l*, pericycle. × 150

(Fig. 8) from four to eight epidermal cells are in contact with one cortex cell. The long axis of these cells is parallel to the axis of the root. In the outer layers the cell walls are closely applied, the cells

being therefore regularly hexagonal in cross section: in the inner cortical layers the cells are not closely compacted, are elliptical in cross section (Fig. 9), and show large intercellular spaces. The protoplasmic contents stain less intensely than in the case of the epidermal cells. Numerous starch grains appear in nearly all the cortical cells.

Lying within the primary cell layer of the cortex is the endodermis, consisting of cells somewhat smaller than those of the cortex and, so far as observed, devoid of starch grains. The pericycle consists of a layer of cells of approximately the four-sided prismatic form, the long axis lying in the periphery of the section at right angles to the axis of the root. These cells measure 60 μ to 90 μ along the longer axis and 45 μ to 75 μ along the shorter axis. Within this and entirely surrounding the xylem is the cambium layer.

The xylem is composed of pitted tracheae 15 μ to 30 μ in diameter and 112 μ to 210 μ long. This is the only type of wood element observed in the root of Spigelia. Within the inclosing ring formed by the xylem are the parenchyma cells of the pith. In the oldest roots examined the center of the axis was almost wholly composed of xylem tissue, and the pith parenchyma is probably best regarded as temporary only.

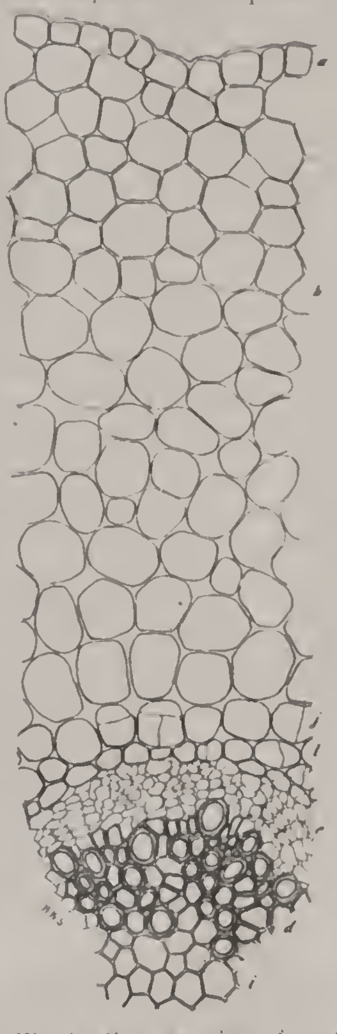

Fig. 9. Cross section of root of *Spigelia marilandica* L. *a*. epidermis; *b*. cortex; *d*. xylem; *e*. cambium; *i*. pith; *j*. endodermis; *l*. pericycle. 150.

CHEMISTRY OF THE PLANT.

Of the numerous contributions made to the chemistry of *Spigelia marilandica* L. that of Feneulle must be regarded as the first of importance, since the view is now generally accepted that he really

worked with this plant and not with *Spigelia anthelmia* L. as he supposed. In 1823 Feneulle[1], a chemist and druggist of Cambria, made an extended qualitative examination of the chemistry of the plant which he held to be *Spigelia anthelmia* L. and published his results as follows:

The powdered root was treated with sulphuric ether until solution was effected, when the solution was of a lemon-yellow color, and turned litmus red. This was reduced to one-sixth of its volume by distillation, and the liquid remaining in the retort was left to evaporate spontaneously. The ethereal distillate did not contract any odor and was not acid. The residue was strongly acid and on diluting with distilled water a soft, fat, unctuous substance separated, of acid taste and accompanied with a little resin. The aqueous solution precipitated salts of iron peroxid black, and contained gallic acid with a bitter substance.

A second portion of the root treated with ether was boiled and treated with pure alcohol. When filtered it deposited nothing, and on distillation left a residue formed of resin, a greenish oil, and a little acid and bitter substance.

A third portion of the root, macerated in distilled water, filtered, and boiled, formed a coagulum which burned like animal matter and was soluble in potash,—albumin. On distillation the remainder gave an aromatic product not affecting litmus but clouding lead acetate and silver nitrate. The decoction remaining in the retort when filtered was transparent, brown in color, bitter, and astringent. With acetate of lead it gave a yellowish white precipitate, which on purification yielded acid malates of lime and potassium. The decoction when freed from the precipitate of lead by hydrogen sulphid, filtered, evaporated, and treated with alcohol left a colored substance of sweetish taste and soluble in water, while the alcohol took up a bitter brownish matter, apparently the active principle. The constituents may be summarized thus: A fatty oil; a volatile oil; resin, small quantity; bitter substance; muco-saccharin matter; gallic acid; albumin; malates of lime, potash, etc.; lignin.

Three years later Wackenroder[2] made *Spigelia marilandica* the subject of chemical research. He carefully states that the confusion

[1] Feneulle, H. Analyse de la Spigélie Anthelminthique. Journal de Pharmacie et des Sciences Accessoires, 9:197. 1823.
[2] Wackenroder, H. G. F., De Anthelminthicis, p. 52, Göttingen, 1826.

between this species and *Spigelia anthelmia* may be avoided by noting that the latter has annual roots. In his analysis he used the entire plant, investigating the roots as well as the stem and leaves. His results are as follows:

Stem and leaves:

Resin, chlorophyll	2.40
Myricin	.30
Resin (special)	.50
Tannin	17.20
Lignin	75.20
Malate of potassium and KCl	2.10
Malate of lime	4.20

Root:

Bitter resin and fatty oil	3.13
Tannin	10.50
Extractive	4.84
Lignin	82.69

The next to study this plant chemically was Stabler[1], who studied the root of Spigelia, but whose work was qualitative only and undertaken to determine, if possible, the seat of the active principle and the nature of the volatile oil to which the odor of the root is believed to be due. His analysis gave as constituents of the rhizome and roots a bitter, uncrystallizable principle to which the activity was ascribed, a small quantity of volatile oil, tannic acid, inert extractive, wax, resin, and salts of potassium, sodium, and lime. The active principle is acrid and bitter, soluble in water and alcohol insoluble in ether, decomposing on volatilization, neutral and deliquescent.

In 1879 Dudley[2] was led to suspect the presence in Spigelia of a volatile alkaloid, since the activity is reputed to become somewhat diminished in the old roots. He submitted the root of the drug to distillation with milk of lime over a paraffin bath, received the distillate in hydrochloric acid and evaporated it to dryness over a water bath, and purified it by extraction with absolute alcohol. The alcoholic filtrate when evaporated yielded a crystalline substance which was water soluble. In solu ion this substance gave with iodin-potassium-iodid a brownish-red precipitate, with metatungstic acid a white

[1] Stabler, R. H. On Spigelia. Proc. Amer. Pharm. Assoc., 6:132—134, 1857.
[2] Dudley, W. L. Preliminary Notice of a New Volatile Alkaloid. Amer. Chem. Jour., 1:154—155, 1879—80.

flocculent precipitate, and with potassio-mercuric iodid a white crystalline precipitate. This latter reaction seems to distinguish it from the other volatile alkaloids with which it was compared, as nicotine and lobeline, which gave a yellow precipitate. As a result of this work the name spigeline was assigned to the new volatile base whose presence was indicated.

A comparative analysis of the true pinkroot was made by Boynton[1] in 1884 with a view to furnishing data for distinguishing it from the Carolina phlox which was supposed to be substituted for it. His results were very general and can be regarded only as a proximate analysis, since he found neither the active principle nor the volatile oil which previous workers had demonstrated. According to his published statement the analysis gave the following as constituents of *Spigelia marilandica:*

Moisture	8.621
Benzol extract (resin, wax, fat)	.518
Alcohol extract (resin, tannin, extractive)	7.418
Water extract (gum, tannin, extractive)	11.008
Ash	20.500

These accounts on comparison are seen to be indefinite and contradictory, and beyond the statement that the plant contains resin, starch, and tannin, little can be said. A careful and thoroughgoing analysis is needed to determine its actual constituents.

MEDICINAL PROPERTIES.

The chief characteristic of spigelia, and the one which first attracted favorable notice, is its action as a vermifuge, and it has long been recommended as a powerful anthelmintic. Chalmers, Garden, and Lining, who first introduced spigelia to the medical profession, regarded it as the best remedy for the very prevalent worm disorders of their time. These authors cite several instances from their private practice in which desperate cases of worms were cured by the administration of pinkroot.

A number of authors claim for spigelia narcotic properties. Lindley[2] observed that its use was occasionally accompanied with

[1] Boynton, W. C. Laboratory Notes. Amer. Jour. Pharm., 56:570, 1884.
[2] Lindley, J. Introduction to the Natural System of Botany, p. 216, 1831.

violent narcotic effects. Eberle [1] found that a strong decoction of the root showed narcotic properties and produced in a child symptoms similar to those caused by stramonium seed, and Bigelow [2] states that it is narcotic in large quantities. Hale [3] found that spigelia in addition to being a powerful anthelmintic possessed narcotic and to some extent cathartic properties. Spalsbury [4] observed that unusual symptoms attended the use of spigelia, the most important of which are irregular pulse, strabismus of the eye, dilatation of the pupils, and nervous tremors.

Other disagreeable and alarming symptoms frequently followed the use of this drug, according to some practitioners. Chalmers [5], who esteemed it as the best of vermifuges, reported that its use was often attended with drowsiness, pain in the forehead and eyes, and dimness of sight; in two cases convulsions supervened which terminated in death. Garden [6] also observed a variable effect from the use of this root and regarded large doses safer than small, as the latter were more frequently followed by alarming symptoms of nervous disturbance. Home [7], on the other hand, performed a large number of experiments with spigelia but observed none of the undesirable effects attributed to its action, even though the drug was given in large doses. Thompson [8] performed a number of experiments with a view to determining more definitely the physiological properties of spigelia. Large earthworms placed in a decoction of the root were quickly stupefied and died after a few minutes, and doses of the powdered root administered to a dog caused the death of a huge worm which infested its digestive tract. From these and other similar results Thompson inferred that spigelia possessed great anthelmintic properties. From a series of experiments upon himself and some of his colleagues he learned that spigelia caused cardiac depression, and therefore concluded that it might be useful as a febrifuge. He observed no instance in which the drug had a tendency to produce con-

1 Eberle, J. Materia Medica and Therapeutics, vol. 1, p. 214, 1834.
2 Bigelow, J. American Medical Botany, vol. 1, p. 142, 1817.
3 Hale, J. Report on Medical Botany of the State of Louisiana. New Orleans Med. and Surg. Jour., 9:167, 1853.
4 Spalsbury, G. W. Unusual Effects from the Use of the Spigelia marilandica. Boston Med. and Surg. Jour., p. 72, April, 1855.
5 Chalmers. An Account of the Weather and Diseases at South Carolina, vol. 1, p. 67, 1776.
6 Garden, A. An Account of the Indian Pink. Essays and Observations Physical and Literary, 3:146, 1771.
7 Home, F. Clinical Experiments, p. 420, 1780.
8 Thompson, H. Experimental Dissertation on the Spigelia Marilandica or Indian Pink. 1802.

vulsions, dimness of sight, or dilated pupil, and ascribed these symptoms when they occur to the disease itself, believing that they had been wrongly mistaken for the operation of the drug on the system.

In contrast to the view of Garden and of Buchan [1] that the bad effects of spigelia are due to its administration in small doses, Bartholow [2] believed that moderate doses stimulated intestinal movement and accelerated the action of the heart, and that large doses caused vertigo, dim vision, dilated pupils, convulsions, etc. Dewees [3] also thought that the evil effects were due to large doses or overdoses. It is now generally held that a small dose produces little effect on the system, that a moderate dose, though variable in action, may exert cathartic action, and that a large dose or an overdose will produce the disagreeable symptoms referred to above.

The physiological reaction of lower animals to spigelia was investigated by Hare [4], who found that it produced in them symptoms of poisoning, including strabismus, dilatation of pupil, loss of spinal motor power, and central inhibition of circulation followed by death due to failure of respiration.

For many years the effects of pinkroot have been regarded as undoubtedly variable; sometimes its use has been attended with good results, sometimes none at all. These unequal and uncertain results have been believed to be due to the greater activity of the fresh plant, which gradually diminished as the root dried out and aged. The evil action of spigelia was ascribed almost wholly to the fresh root, and it is said rarely to occur in the dry plant [5]. Hale [6] recommended the use of the fresh root, since he believed that it deteriorated rapidly on keeping, and Dudley [7] was led by the reputed lack of activity in old roots to search for the volatile alkaloid which he claims to have isolated from spigelia. Murray [8] attributed the absence of unpleasant symptoms following the use of the plant in England to the fact that it is used there only in the dried state. Under present methods of

1 Buchan, W. Domestic Medicine, p. 608, 1825.
2 Bartholow, R. A Practical Treatise on Materia Medica and Therapeutics. ed. 5, p. 657, 1884.
3 Dewees, W. P. A Treatise on the Physical and Medical Treatment of Children, p. 456, 1825.
4 Hare, H. A. The physiological Action of Spigelia or Pinkroot. Medical News, 50:286, 1887.
5 Medical Botany or History of Plants in the Materia Medica. vol. 1, p. 31, 1821.
6 Hale, J. l. c.
7 Dudley, W. L. Preliminary Notice of a new Volatile Alkaloid. Amer. Chem. Jour., 1:154, 1879—80.
8 Murray, J. System of Materia Medica and Pharmacy, p. 278, 1824.

preparation by far the largest part of the pinkroot becomes fully dried before use, and may remain in the drug lofts several years before it is worked up into its officinal preparations. This may account for the fact that the comparative merits of fresh and dry roots have attracted almost no attention for over thirty years.

The writers of fifty years ago paid considerable attention to the poisonous action of spigelia. Bureau [1] regards it as a narcotic poison which in extreme cases can cause death. Brown [2] prescribes a tincture of pinkroot in worm mixtures, but cautions against the plant sold as such by the druggists, much of which he says is poisonous. The only statement of poisoning attributed to pinkroot observed in modern literature is that of Free [3], who records as recently at 1894 a case in which a mixture of spigelia and senna was administered, the death which followed being attributed to the poisonous property of the pinkroot.

The bad effects that have been observed in the use of pinkroot have been attributed to some other plant inadverently or fraudulently collected and sold as spigelia [4], while Ewell [5], who recommends its use as a febrifuge, also ascribes its deleterious action to admixture with some other root. Although the drug is now in general use in both regular and domestic practice in the United States, little has been heard in recent years of its undesirable action.

[1] Bureau, L. E. De la Famille des Loganiacées. Thèse Fac. Méd., Paris, pp. 132—145, 1856.
[2] Brown, O. P. The Complete Herbalist, p. 195, 1867.
[3] Free, J. E. Pinkroot Poisoning. Med. and Surg. Reporter, 70:633, 1894.
[4] Kost, J. Elements of Materia Medica and Therapeutics, p. 356, 1858.
[5] Ewell, J. The Medical Companion, ed. 5, p. 605, 1819.

EAST TENNESSEE PINKROOT.

DISCOVERY OF BOTANICAL SOURCE.

The presence on the market of a root extensively substituted for spigelia has long been recognized, and it has been widely commented on by writers on medicinal plants, to whom, however, the botanical source was unknown.

For some time this subject had received the attention of Dr. Rodney H. True and he demonstrated several years since to his own satisfaction that an unsuspected substitute had crept into the market and to a considerable degree had replaced the true article. It was shown in 1900, by Mr. S. J. Poole, a student of botany at Harvard University working under Dr. True's direction, that the substitute belonged to the genus *Ruellia* of the family *Acanthaceae*. The significance of this substitution with reference to the commercial and medical status of pinkroot was pointed out.

In directing the experiments of the office of Drug Plant Investigations of the Bureau of Plant Industry, Dr. R. H. True [1], in 1903, with the purpose of learning something more definite concerning pinkroot, ordered from a dealer in eastern Tennessee plants of *Spigelia marilandica* for cultivation at Washington, D. C. The plants received when the order was filled had slender, hairy stems and elliptical, hairy leaves. They were placed under close observation and upon flowering were positively identified as *Ruellia ciliosa* Pursh (Fig. 2).

The significance of this discovery can best be appreciated when it is remembered that there exists a widespread confusion concerning this plant. According to some authors whose statements have been unquestioned for years this false pinkroot was the Carolina phlox (*Phlox ovata* L.). Others have examined the rhizome and root microscopically and chemically while under the impression that they were dealing with spigelia. Clinical observations on the action of spigelia have been recorded which are not free from the suspicion that they belong in reality to Ruellia. These errors also appear in the latest text-books, dispensatories, and materia medicas, and are being continually multiplied and distributed throughout the literature of the subject.

MORPHOLOGICAL CHARACTERS.

East Tennessee pinkroot (*Ruellia ciliosa* Pursh) is a member of the family *Acanthaceae*, which comprises about 175 genera widely distributed in temperate and tropical regions.

[1] True, R. H. Pharm. Rev., 21:364, 1903.

This plant, growing in dry soil in woods and thickets, is an herbaceous perennial with an erect stem which frequently sends out lateral branches. The stems and leaves are markedly hairy, a character which is less pronounced in *Ruellia strepens* L. and *R. parviflora* (Nees) Britton. The leaves are opposite, sessile and very short petioled, oblong or oval, with margins entire or rarely dentate. The rather large and showy flowers are borne in the axils of the leaves and may be single or clustered. The bluish-purple corolla has a straight or more or less curved tube, abruptly dilated above, terminating in a border with five obtuse lobes. The four stamens are borne on the corolla and are nearly equal in length or didynamous. The filaments are enlarged toward the base and are united two by two in a variable degree. The fruit is a two-valved capsule containing six to many seeds.

The rhizome (Fig. 10) is short and erect and has a small central

Fig. 10 Rhizome and roots of *Ruellia ciliosa* Pursh.
At a, a is shown the tough yellow wood left on the breaking away of the readily removable bark.

pith and thick, hard wood. The roots are coarse and straight, sometimes wiry in appearance, the color varying from yellowish-brown to dark-brown. The roots are usually uniform in diameter throughout the greater portion of their length, giving off but very few small and fibrous branches. The bark of the roots is readily removable and frequently breaks off in handling, leaving the tough, wiry, straw-colored wood.

Of the three species of *Ruellia* mentioned above, *R. ciliosa* Pursh has the widest range in the United States. It occurs from New Jersey to Florida, Michigan, Kansas, and Louisiana. The flowering season

is from June to September.[1] *R. strepens* usually flowers earlier and generally occurs in about the same situation and range as *R. ciliosa*. *R. parviflora*, or southern *Ruellia*, occurs commonly in the United States south of Maryland and West Virginia and as far west as Texas.

ANATOMY.

The general facts concerning the anatomy of the *Acanthaceae* are summarized by Solereder[2], who makes very prominent, especially as a character in classification, the occurrence of cystoliths, a structure characteristic of numerous genera of this family, including Ruellia.

Dethan[3] studied several species of *Ruellia* and gives an account of the anatomical structure of *Ruellia patula* Jacq. and *R. tuberosa* L., neither of which, however, is known to occur in the range of *R. ciliosa* Pursh.

The material used in this study was obtained from the plants under cultivation on the experimental drug farm at Washington.

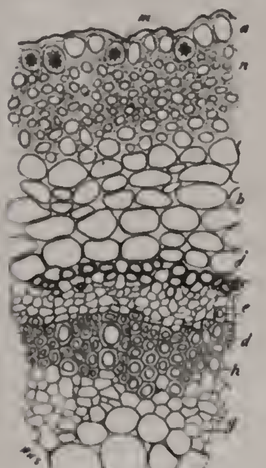

Fig. 11. Cross section of aerial stem of *Ruellia ciliosa* Pursh.

a, epidermis; *b*, parenchymatous cortex; *c*, bast fibers; *d*, xylem; *e*, cambium; *g*, internal phloem; *h*, spiral vessel; *i*, pith; *j*, endodermis; *m*, cystoliths; *n*, collenchymatous layer of the cortex. × 150.

In order to widen the field of observation, as well as to obtain some idea of the extent of the occurrence of Ruellia as pinkroot, a large number of commercial samples were examined and compared with authentic material. Fully 50 per cent. of these samples consisted wholly of Ruellia, and many of the remainder contained Ruellia in varying though usually large quantities.

Anatomy of the stem. The aerial stem of *Ruellia* is distinctly four-angled, and is almost square in cross section (Fig. 11). The pith is composed of regular, elliptical, thick-walled parenchymatous cells between which large intercellulars occur. The pith cells as well as those of the cortex are devoid of starch. A layer of internal phloem surrounds the pith. The layer is thickest at the angles of the stems, where there is also a greater development of the mechanical tissue.

[1] Britton, N. L. Manual of the Flora of the United States and Canada, 1901.
[2] Solereder, H. Systematische Anatomie der Dicotyledonen, p. 696, 1899.
[3] Dethan, G. Des Acanthacées Médicinales, p. 81—86, 1896.

The xylem is disposed in a woody ring which follows closely the general shape of the stem. It is thickest at the angles of the stem, where also the vessels are largest and most numerous. In the inner portions of the xylem spiral vessels occur, some large with a close spiral, some small with a loose spiral. Large annular vessels and wood cells with simple pits make up the remaining xylem.

Outside the wood and entirely surrounding it is a narrow few-celled layer of cambium. The external phloem is limited exteriorly by a thick pericycle, in which occur numerous long fibers, elliptical in cross section and having a relatively large lumen. The cells of the endodermis are large and show the characteristic cuticularization in their lateral walls. The endodermis is readily recognized, though its cells differ little in size and general appearance from those of the cortex.

In the stem, as well as in the root and rhizome of Ruellia, the cortex is differentiated into an outer collenchymatous layer and an inner portion of large, relatively thin-walled, elliptical parenchymatous cells. Cystoliths and sclereids are absent from the inner portion of the cortex, in which large intercellulars occur. Starch is absent from the cells. The outer portion of the cortex, comprising six to eight layers of cells, is composed of collenchymatous cells of about half the diameter of the inner cortical cells. Cystoliths and sclereids are absent here as well as in the inner layers.

The epidermis consists of a single layer of cells elliptical in cross section (Fig. 11) and larger than those of collenchyma. The outer walls are thickened, and usually give a satisfactory cutin reaction. In longitudinal section (Fig. 12) the cells are several times longer than in cross section. Numerous cystoliths occur in the epidermis. While the cells containing cystoliths may not strictly be termed sub-epidermic, they are larger than the other epidermal cells and appear to push down into the cortex as though an increase in size had occurred in the cystolith-bearing cells after

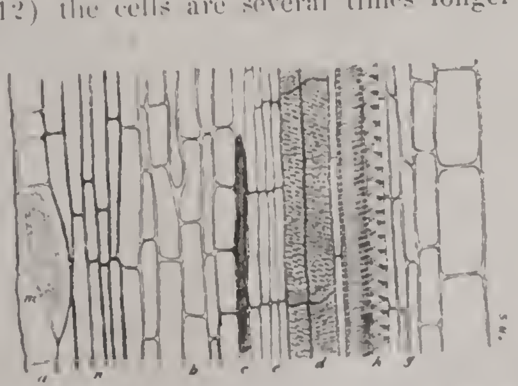

Fig. 12. Longitudinal section of aerial stem of *Ruellia ciliosa* Pursh. Letters signify as in Fig. 11. × 150.

the epidermis had fully formed. The surface of the stem is thickly set with epidermal hairs which arise as extensions of the epidermal cells. These are of two kinds, multicellular gland hairs, and simple, pluricellular, non-glandular hairs, the latter being curved and having the apex uniformly directed toward the base of the plant.

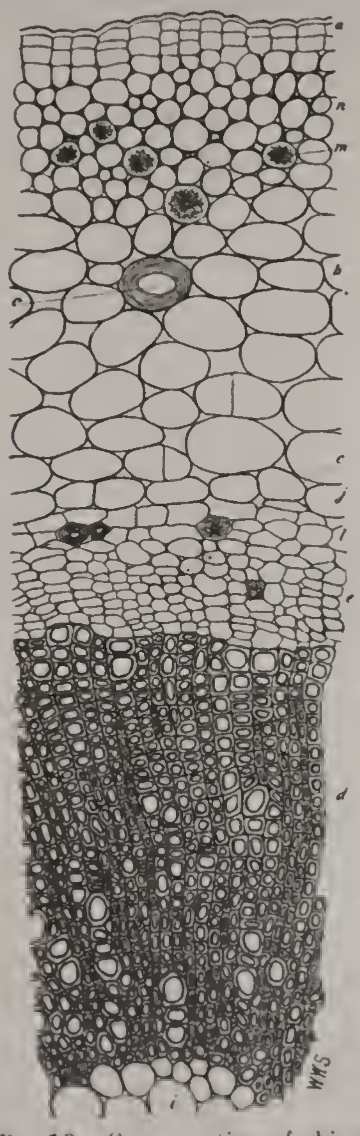

Fig. 13. Cross section of rhizome of *Ruellia ciliosa* Pursh.

a, epidermis; b, cortex; c, bast fiber; d, xylem; e, cambium; i, pith; j, endodermi; l, pericycle; m, cystolith; n, collenchyma; o, sclerid. ×150.

In longitudinal section the cystoliths are fusiform or conical and occupy the larger epidermal cells. In life the cells not bearing cystoliths contain a coloring matter which imparts the purplish color characteristic of the stem.

Anatomy of rhizome. The structure of the rhizome differs in several important particulars from that of the stem. The relatively small pith is composed of large, thick-walled parenchyma cells devoid of starch grains. The perimedullary sieve tissue is absent in the mature rhizome. The wood is thick, composed of simple pitted cells and vessels. Large vessels occur between the somewhat indistinct medullary rays. The few to several celled cambium layer is limited by the pericycle, in which occur a few thickened sclerenchyma fibers. The endodermis is distinct and clearly shows the characteristic lateral thickenings.

The cortex, like the stem, is differentiated into an outer and an inner zone. The latter consists of large parenchymatous cells, elliptical in cross section (Fig. 13) and displays large intercellular spaces. Frequent sclereids of a yellow color

occur in this zone. They are strongly lignified, oval in cross section, and show the characteristic concentric markings. In longitudinal sections (Fig. 14) they are nearly rectangular and show numerous pore canals. The outer zone consists of collenchymatous cells much smaller than those of the inner cortex, and exhibits numerous cystoliths. They are very similar to those occurring in the stem. A few-celled corky layer is present in mature plants. The epidermal cells are thickened on the external wall.

Anatomy of root. The mature root of Ruellia has a central cylinder of the pentarch type, surrounded successively by phloem, pericycle, and endodermis. In young roots, the pith cells are thin-walled

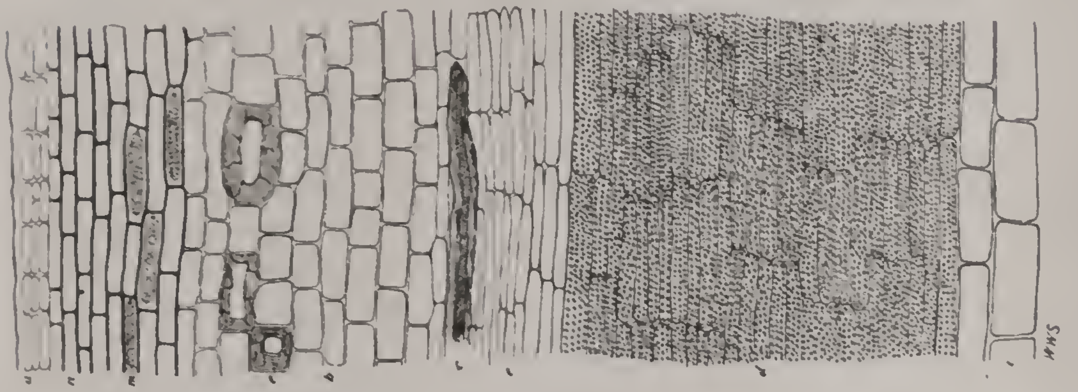

Fig. 14. Longitudinal section of rhizome of *Ruellia ciliosa* Pursh.

a, epidermis; *b*, parenchymatous cortex; *c*, bast fiber; *d*, xylem; *e*, cambium; *l*, pith; *m*, cystolith; *n*, collenchymatous layer of cortex; *o*, sclereid. ×150.

and parenchymatous, but in the mature condition these cells are strongly thickened and give an intense lignin reaction with phloroglucin and hydrochloric acid.

The xylem cells are in general hexagonal in cross section (Fig. 15); the thickened walls are marked by simple elliptical or slit-like pits. The phloem which surrounds the xylem has thin-walled cells of irregular cross section. In the outer layers occur groups of bast fibers, usually five in number, between which the medullary rays extend, marking the individual bundles forming the stele. These fibers are from 0.3 to 1.5 mm. in length, elliptical in cross section, and show a small central lumen. The pericycle appears as a layer of thin-

walled parenchyma cells of regular oval outline, limited externally by the endodermis, which is here a ring of elliptical cells with dark walls somewhat thicker than those of the adjacent tissue.

The thick cortex surrounding the stele shows, as in stem and rhizome, a differentiation into two zones. The three to five celled outer layer consists of collenchymatous cells in which occasional cystoliths occur. The inner layer is made up of thick-walled parenchymatous cells, frequently inclosing cystoliths and numerous sclerenchymatous cells which give the characteristic reactions for lignified tissue. The cells of the outer cortical layer are much smaller than those of the inner layer.

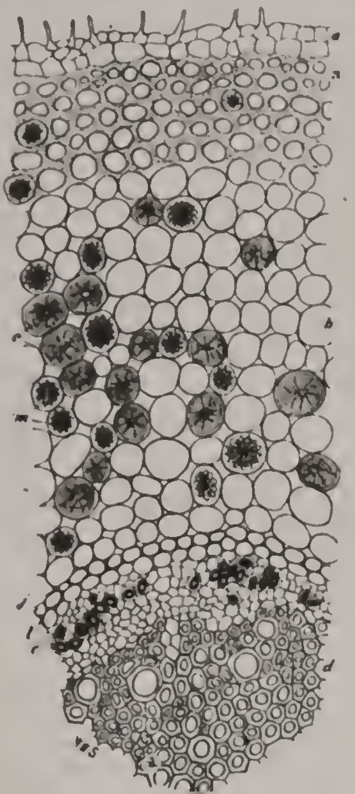

Fig. 15. Cross section of the root of *Ruellia ciliosa* Pursh.

a, epidermis; *b*, cortex; *c*, bast fibers; *d*, xylem; *j*, endodermis; *l*, pericycle; *m*, cystoliths; *n*, collenchyma; *o*, sclereids. × 150.

The cystoliths characteristic of this plant occur abundantly in the cortical cells. In cross section they are circular or elliptical, and show a series of concentric stratifications. Portions of the surface of cystoliths are produced into tooth-like projections. In longitudinal section (Fig. 16) they appear rounded at the end which is attached, and taper toward the lower extremity. In the presence of hydrochloric acid rapid effervescence occurs, due probably to calcium carbonate, which is believed to be the chief constituent of cystoliths. The attachment is not evident except in fresh material, in which it was demonstrated at the large rounded end.

A one to three celled corky layer underlies the epidermis. The epidermis itself comprises a single layer of cells with walls somewhat thickened. The surface of the growing root is thickly beset with long, simple, unicellular hairs which arise as modified epidermal cells.

Chemistry of the Plant.

Almost nothing is known of the chemistry of *Ruellia*. The members of this genus which have medicinal properties are used almost exclusively in tropical or subtropical countries and have not been thoroughly studied. Such facts as are available concerning the constitution of this plant were obtained by a chemist who believed he was studying *Phlox carolina*, but, as will be shown, really used the plant Ruellia in his investigations.

Trimble[1] in 1886 reported an analysis of *Phlox carolina* in the course of which he obtained by the solvent action of petroleum spirit a red and fluorescent solution which upon evaporation deposited a residue in the form of masses of fern-like crystals on the side of the

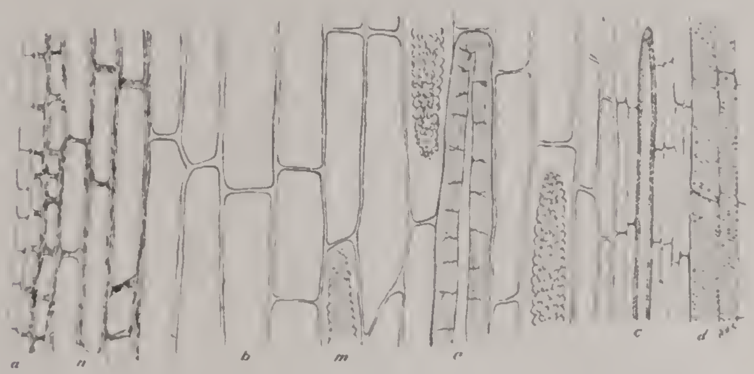

Fig. 16. Longitudinal section of *Ruellia ciliosa* Pursh.
a, epidermis; *b*, parenchymatous cortex; *c*, bast fiber; *d*, xylem; *m*, cystolith; *n*, collenchymatous cortex; *o*, sclereid. × 150

vessel, while in the bottom it formed into star-like circular masses of acicular crystals. The dry residue was then treated with dilute alcohol to remove the red coloring matter, and further purified by crystallizing first from boiling-hot 95 per cent. alcohol and then from absolute alcohol. The compound obtained was soluble in chloroform and ether, melted at 155.4° C., and burned with a smoky flame. In view of its physical and chemical properties he decided that the compound isolated belonged to the camphor group and suggested the name "Phloxol."

Two years later further studies on this compound were reported

[1] Trimble, Henry. An Analysis of the Underground Portion of Phlox Carolina. Amer. Jour. Pharm., 58:474—481, 1886.

by Abbot and Trimble[1], and the results of its ultimate analyses formed the basis for the theory that the compound was an unsaturated hydrocarbon of the formula $(C_{11}H_{18})x$.

For the purpose of comparison Spigelia was similarly treated with petroleum spirit, but no such compound as that obtained from the supposed Phlox was obtained. This result suggested important chemical differences between the two plants and led to Trimble's proposition to use the presence of the so-called phloxol as a means of distinguishing Spigelia from Phlox, a test which has been generally accepted in pharmaceutical literature.

PHLOXOL A CONSTITUENT OF RUELLIA.

The discovery that Ruellia is the botanical source of the East Tennessee pinkroot and the failure to find the Carolina phlox in any adulterated samples of pinkroot examined, suggested the possibility that the plant from which phloxol had been isolated was *not* Phlox but a species of Ruellia. Accordingly an attempt was made to verify the source of the phloxol by the duplication of that part of Trimble's work on Phlox which dealt with the petroleum ether extract and the compound isolated therefrom. Samples of the three plants *Phlox ovata* L. (*Phlox carolina* L.), *Ruellia ciliosa* Pursh and *Spigelia marilandica* L. were taken from the testing gardens of the U. S. Department of Agriculture where they were under cultivation, a condition which made possible the securing of authentic specimens of each plant.

Each sample of this material was first reduced to a fine powder by grinding and was then thoroughly exhausted with petroleum ether. The solutions were then filtered into beakers and the appearance of each observed. That from Spigelia remained clear and uncolored, the one from Phlox had a yellowish tinge, probably due to chlorophyl dissolved from leaf fragments intermingled with the roots before grinding, while the solution from Ruellia was red and fluorescent, as described by Trimble for Phlox.

Upon evaporation the solution from Spigelia deposited a gummy mass on the bottom of the beaker, throughout which occurred masses

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1 Abbot, Helen, and Trimble, H. On the Occurrence of Solid Hydrocarbons in Plants. Amer. Jour. Pharm., 60:321—324, 1888.

of small sphaero-crystals. The solution from Ruellia deposited fern-like masses on the side of the beaker and on the bottom groups of acicular crystals, similar to those reported as derived from Phlox. After purification by recrystallizing from alcohol, the melting point was found to lie between 153° and 155° C., results which agree very closely with those given for phloxol [1].

These experiments furnish good evidence for the following conclusions: (1) That Trimble did not have the Carolina phlox as he supposed, but probably Ruellia; (2) that the so-called phloxol is not a constituent of *Phlox ovata*, but in all probability occurs in Ruellia.

MEDICINAL PROPERTIES OF RUELLIA.

It is not possible at present to ascribe any specific medicinal properties to *Ruellia ciliosa*, although several other members of the genus have some well-recognized uses in certain maladies. Dethan [2] has given an extended account of the useful Ruellias in his thesis on the medicinal *Acanthaceae*. The value of his work, however, is diminished by the careless and incorrect citation of his authorities. Some of these inaccuracies are repeated by Bocquillon [3] in a very recent work: hence only such statements of these two authors as could be verified from original sources have been credited.

The roots of *Ruellia tuberosa* L., *R. patula* L., *R. hispida* Rich., and *R. strepens* L. are emetic and are used in America as a substitute for ipecac [4], the two former being similarly used in the Antilles [5]. In Guiana and the Antilles *R. tuberosa* L. is employed in intermittent fevers, whooping cough, puerperal peritonitis, etc. [6] In the Barbados the root has a great reputation among the natives as a cooling diuretic [7]. In the East Indies the natives bruise the leaves of *R. strepens* L., and mix them with castor oil, forming a valuable application in cases of children's eruption due to dentition [8]. *R. repanda* L. is employed in the treatment of cases of angina and conjunctivitis. [4]

[1] Further studies on this compound are in progress in the laboratories of Drug-Plant Investigations of the Bureau of Plant Industry U. S. Department of Agriculture.

[2] Dethan, G. Des Acanthacées Médicinales, pp. 80—86, Paris, 1896.

[3] Bocquillon-Limousin, H. Manuel des Plantes Médicinales, p. 244, Paris, 1905.

[4] Baillon, H. Histoire des Plantes, 10:421, 1891

[5] Dechambre, A. Dictionnaire Encyclopédique des Sciences Médicales, 5:583, 1877.

[6] Corre and Lejanne. Résumé de la Matière Médicale et Toxicologique Coloniale, p. 124, 1887.

[7] Freeman, W. G. Notes from Barbadoes. Pharm. Jour. and Trans., 67:615, 1901.

[8] Ainslee, W. Materia Indica, vol. 2: p. 153, 1826.

In the Antilles an infusion of the leaves of *R. coccinea* Vahl. is used as a diuretic, and a sudorific preparation is made from the buds [1]; here also *R. clandestina* L. serves for a febrifuge [2], and the blue flowered Ruellia, or *herbe a chandeliers,* is used as a sudorific (Belanger) [3]. In Sennar and Nubia *R. nubica Delile,* is employed in the treatment of various diseases [4].

Although Ruellia ciliosa Pursh is the only member of the genus positively identified as a substitute for Spigelia, it is still quite probable that *R. parviflora* (Nees) Britton and *R. strepens* L. also occur as East Tennessee pinkroot, since all three forms are well distributed over a large area in the eastern and southern United States. The habitat, form, and general appearance of the three species are not sufficiently distinct to render them readily distinguishable to collectors. In view of the fact that *R. strepens* L. has some well-marked physiological properties, the possibility of its presence in the crude pinkroot may in some degree account for the variability in action which has long been observed in Spigelia.

MINOR ADULTERANTS OF SPIGELIA.

Aside from Ruellia the adulterants of Spigelia may be regarded as accidental, due in the main either to the carelessness of the collector in not sorting out the roots with which the plant would be associated in its growth, or to a lack of familiarity with the plant on the part of young or inexperienced collectors. In Spigelia other roots sometimes occur which have a market value from two to four times greater than that of the true pinkroot and therefore can scarcely be regarded as intentional adulterants. Doubtless some of these are introduced in the drug lofts where large quantities of various roots are stored and handled. The worthless roots sometimes present, however, may have been introduced by the collector with full knowledge that a fraud was being perpetrated.

A very brief notice of some of these adulterations is all that the limits of this paper warrant, with the exception of one reputed to be of great importance but which it is believed rarely, if ever, occurs.

1 Corre and Lejanne. Résumé de la Matière Médicale et Toxologique Coloniale, p. 46, 1887.
2 Baillon, l. c.
3 Corre and Lejanne, l. c., p. 124.
4 Dechambre, l. c.

PHLOX CAROLINA.

Mention has been made in the historical account of the fact that the Carolina phlox was believed to be substituted for Spigelia. In connection with the observations on the chemistry of the Tennessee Pinkroot it was shown that the supposed Phlox was probably Ruellia. There now remains to describe authentic material of this plant and to show not only that Ruellia as an adulterant of Spigelia has been wrongly referred to Phlox but also that there are no valid reasons for believing that Phlox occurs at all, except perhaps in rare cases, as an adulterant of Spigelia.

Botanical Description.

The Carolina Phlox, formerly known as *Phlox carolina* L., but now called *Phlox ovata* L., is an herbaceous perennial of the family *Polemoniaceae*. The simple stems are from one-half to two feet high, often ascending from a prostrate base. The leaves are opposite and entire, the upper ones sessile, ovate-lanceolate, with acute tips, the lower longer, oblong or ovate-oblong, acute, and narrowed into slender petioles. The corolla has a long, slender tube, with a spreading border of five rounded entire lobes. The color is pink or a delicate rose-red. The short stamens are unequally inserted on the corolla tube. A three-parted style terminates the three-celled ovary.

From the thick and branching stem base spring numerous large, gnarled and crooked, much-branched fibrous roots. These are at first light colored, becoming dark brown when quite old. The bark sometimes breaks away from the wood in the old roots, but much less freely than is the case with Ruellia. The roots are thicker and coarser than those of Spigelia or Ruellia, while in the smaller roots the successive branches are given off almost at right angles, thus presenting a very striking characteristic.

Anatomy.

For the anatomical work fresh specimens of *Phlox ovata* L. were obtained from authentic plants under cultivation, and material obtained from the United States National Herbarium was used for comparison. The living material was examined in the spring when the plants had reached the height of a few inches and again late in the autumn when they were preparing to enter the winter condition.

The aerial stem of the specimens examined was smooth, terete, and about 2 mm. in cross section (Fig. 17). The pith is large and central, composed of large parenchymatous cells, in cross section irregularly hexagonal and isodiametric. Toward the periphery of the pith the cells have thickened walls, while at the center the walls are thin and cellulosic. Surrounding the pith is a group of cells belonging to the woody parenchyma but not yet lignified. This tissue resembles the internal phloem of Spigelia, a structure which is not present in Phlox.

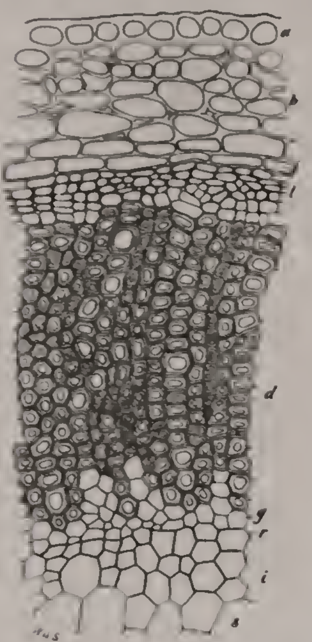

Fig. 17. Cross section of stem of *Phlox ovata* L.

a, epidermis; b, parenchymatous cortex; d, xylem; g, internal phloem; i, pith; j, endodermis; l, pericycle; r, thick-walled pith cells; s, thin-walled pith cells. × 150.

The wood is thick, being made up of thick-walled, more or less regular, simple-pitted cells, hexagonal in cross section. The medullary rays are not sharply defined in the younger stages of the stem's growth. The vessels are large but not numerous in the young stems and usually are more frequent toward the center. The phloem appears as a narrow discontinuous layer, interrupted by the cells of the pericycle, which are at intervals contiguous with the wood. The pericycle, a continuous layer of varying thickness, is formed of thickened cells, irregular or oval in cross section. The endodermis is distinct, the cells are large and plainly show the characteristic thickening of the lateral walls. The cortex is narrow and consists of large, thick-walled parenchymatous cells, irregularly oval in cross section. The epidermis consists of regular oval cells, strongly cutinized, and, in all specimens examined, devoid of hairs.

The underground portion of the stem differs from the aerial stem in several important particulars. The pith is large and contains scattered cells with much-thickened, lignified walls. The wood is less compact than that of the aerial stem and exhibits large spiral vessels toward the center. The pericycle is broad and the cells composing it have thicker walls than the corresponding structure in the aerial stem.

The relatively thick cortex is composed of regular, elliptical parenchymatous cells, among which occur scattered cells with thickened walls which give a strong lignin reaction. Large intercellulars occur in the cortex. Outside a corky layer of two or three rows of thin-walled cells is the epidermis, which is slightly cutinized and composed of cells with walls thinner than those of the epidermis in the aerial stem.

In the root the fibrovascular bundle is of the radial type, triarch in the young root, and occupies the center of the stem, there being no pith. The cells of the xylem are thick-walled, hexagonal in cross section (Fig. 18), and have simple-pitted walls. A few scattered spiral vessels occur in the xylem. A continuous band of phloem parenchyma surrounds the xylem, which in turn is limited by the pericycle, consisting of two or three layers of large-sized, thick-walled cells. The endodermis is thin-walled, the cells exhibiting tangential elongation.

Large, thick-walled parenchymatous cells comprise the cortex. They are in general oval in cross section, having large intercellular spaces between them. Two layers of cells with brownish walls constitute the epidermis and exodermis. The cell walls are in close apposition, leaving no intercellulars. The cells of the outer layer are smaller than those of the inner, somewhat elongated tangentially, and externally thickened. They give rise to the root hairs. The exodermis consists of thin-walled usually pentagonal cells.

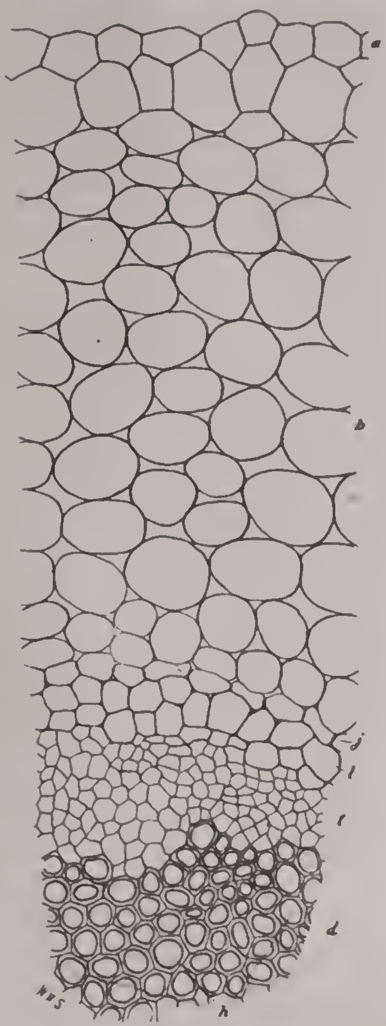

Fig. 18. Cross section of root of *Phlox ovata* L.
a, epidermis; *b*, cortex; *d*, xylem; *h*, spiral vessels; *j*, endodermis; *l*, pericycle; *t*, phloem parenchyma. × 150.

Theory that Phlox is a Substitute for Spigelia.

The first account of the substitution of the Carolina phlox for Spigelia is given in the report of the Committee on Adulterations and Sophistications to the American Pharmaceutical Association at its Twenty-third Annual Meeting in 1875[1]. A sample of the false pinkroot was sent by the members of this committee to Wallace Brothers, of Statesville, N. C., who identified it as the root of *Phlox carolina* L., known with them as the Carolina pink. In the observations made on this material the roots of the Phlox were described as straight and uniform in diameter, with an epidermis easily detached, exposing a smooth, straw-colored, ligneous thread. This description became especially significant as the comparative study of the substitutes for Spigelia progressed, for, as has been stated, it was observed to be a perfect characterization of the root of Ruellia.

Some years later Maisch[2], at a pharmaceutical meeting held in Philadelphia, referred to the entire or partial replacement of Spigelia by one or more species of Phlox, principally *Phlox carolina* L. Since different species of Phlox as well as *Spigelia marilandica* were known in the Southern States as Carolina pink, he suggested that the root of Phlox may have been first employed and after its virtues had been learned the root of Spigelia was used. Evidently accepting as assured the theory of the occurrence of Phlox and wishing to contribute something to the methods of distinguishing the roots of these plants, Boynton[3] published a summary of the results of a comparative analysis of *Spigelia marilandica* and *Phlox carolina*.

Trimble[4] assumed that Phlox was an adulterant of Spigelia, and after chemical analysis of what he supposed to be *Phlox carolina* suggested the action of petroleum ether in dissolving certain compounds from the one but not from the other as a means of distinguishing them. The honor of the discovery that *Phlox carolina* was substituted for Spigelia was claimed by Prof. M. E. Hyams[5] in 1890. He states that samples of an invoice received at Philadelphia from Tennessee were sent to him for identification and were found to be

[1] Miller, Mercein, and Peixotto. Proceedings of the American Pharmaceutical Association, 23:508—509, 1875.
[2] Maisch, J. M. Amer. Jour. Pharm., 55:631—632, 1883.
[3] Boynton, W. C. Laboratory Notes. Amer. Jour. Pharm., 56:570, 1884.
[4] Trimble, Henry. An Analysis of the Underground Portions of Phlox Carolina. Amer. Jour. Pharm., 58:479—482, 1886.
[5] Hyams, M. E. The Crude Drug Industry of the South. The Pharmaceutical Era, 4:12—15, Jan., 1890.

Phlox carolina L., but that the honor of the discovery was given to another.

In 1891 Greenish[1] called attention again to the substitution of Phlox for Spigelia and after microscopical examination described and figured sections of a sample of root obtained from Professor Maisch, who stated that he had received it some years before as *Phlox carolina*. As a means of distinguishing Phlox from Spigelia, Greenish cites the presence in the cortex of numerous stone cells and cells inclosing cystoliths composed chiefly of calcium carbonate impregnating a cellulose skeleton. In tangential sections he observed that the stone cells were of great length, and that the cystoliths were in general cylindrical in shape. These structures were found in the parenchymatous tissue of the rhizome and aerial system as well as in the root.

In his Materia Medica Maisch[2] says that Spigelia "should not be confounded with the rhizome of *Phlox carolina*, Linné (like Spigelia known as Carolina pink), which is short, upright, and has a central pith, hard wood, and brownish-yellow, rather coarse, straight rootlets containing a straw-colored wood underneath a readily removable bark; benzin extracts from it a crystalline white, tasteless hydrocarbon."

The most recent contribution to the literature of this subject is the study of *Phlox carolina* made by Morelle[3] while examining the falsification of Spigelia. His material, obtained from the Museum of Natural History at Paris, consisted of the stem and leaves of *Phlox carolina*; the roots of the specimens, however, were wanting. Two characters which he mentions as serviceable for distinguishing Phlox from Spigelia are: (1) The structure of the epidermal hairs, and (2) the presence of rare cystoliths. He finds that the epidermal hairs are curved, and consist uniformly of a single row of cells. The single cystolith which he observed was rounded in form and situated in a sub-epidermal cell extending well into the cortical parenchyma. Since, however, but a single cystolith was found in all the material he examined, no importance can be attached to his second characteristic.

[1] Greenish, H. C. Note on Phlox Carolina. Pharm. Jour. Trans., ser. 3, 21:839—840, 1891.

[2] Maisch, J. M. A Manual of Organic Materia Medica, ed. 6, p. 129, 1895.

[3] Morelle, E. Histologie Comparée des Gelsemiées et Spigeliées, p. 144 et seq Thèse, Paris, 1904.

His material was too scanty and fragmentary to furnish a reasonable basis for diagnostic characters.

Evidence Against the Theory that Phlox is a Substitute for Spigelia.

After an examination of a large number of commercial samples of pinkroot, a comparison of the structures therein observed with those described by the authors previously mentioned as characteristic of Carolina phlox, led at once to the conclusion that in reality these writers had been working with Ruellia. This belief was supported by the failure to obtain phloxol from Phlox, and further confirmed by careful study of authentic material of *Phlox ovata* and *Ruellia ciliosa*. The straight, wiry rootlets with easily detachable bark noted in the report of the committee referred to in the preceding chapter, the stone cells and cystoliths observed by Greenish, the crystalline compound extracted by Trimble, the character of the roots given by Maisch, and the structure of the epidermal hairs noted by Morelle are all characteristic of *Ruellia ciliosa*, while in *Phlox carolina* there is an entire absence of similar characters. Among all the samples of pinkroot examined, a large percentage of which contained other roots than those of Spigelia, no material was found that could be referred to *Phlox carolina*. Material purchased in the market in 1903 for *Phlox carolina* proved to be composed entirely of Ruellia.

Through the kindness of Dr. Henry Kraemer, of the Philadelphia College of Pharmacy, the private collection of crude drugs of the late Professor Maisch was made available for study during the preparation of this paper. The material relating to pinkroot consisted of twelve specimens, a number of which were evidently commercial samples and were labeled to indicate that they were recognized as substitutions. One specimen labeled "*Phlox carolina*, substituted in place of Spigelia" proved on examination to be Ruellia. In the entire collection no material occurred that could be referred to Phlox.

Specimens of seven different species of Phlox were obtained from the United States National Herbarium and examined for cystoliths and stone cells. In no case were these structures observed, and, further, the peculiar jointed hairs described by Morelle as occurring on *Phlox carolina*, were not present in any of the material examined. The occurrence of cystoliths in the *Polemoniaceae* is not noted by

Solereder[1] in his Anatomy of the Dicotyledons, though he mentions on the authority of Greenish the finding of cystoliths in a plant characterized as *Phlox carolina*.

Professor Greenish, on request, kindly sent the writer for study a specimen of the root which he had received some years since as *Phlox carolina* from the late Professor Maisch. This material on examination proved to be Ruellia and agreed perfectly with the specimen labeled "*Phlox carolina*" in the Maisch collection, of which it had at one time doubtless formed a part. Although Solereder in effect questions the identity of the plant reported on by Greenish, his reference to it in connection with the description of the Polemoniaceae has apparently engendered the view that cystoliths occur in that family. From the evidence at hand this view must be entirely discredited, since the material used by Greenish in his study was not Phlox but a species of Ruellia.

No contributor to the theory of the substitution of Phlox seems to have secured authentic living material for his study, but to have taken it for granted that the adulterant occurring in roots sold as Spigelia had been correctly identified as Carolina phlox, *Phlox ovata*. By whom the supposed identification was made, or what the method of determination was, is not now possible to learn. The error has been made and widely copied and now appears in almost every text-book or work of reference which mentions the medicinal properties of Spigelia.

A careful study of the literature of Spigelia, an examination of the drug now occurring on the market, and in particular the comparative histology of Spigelia, Phlox, and Ruellia must lead to the conclusion that Phlox rarely or never occurs as a substitute for Spigelia, and that the root so generally described and studied as Phlox must be referred to Ruellia.

Medicinal Properties of Phlox.

There is no evidence at the present time that Phlox has any medicinal value. Lindley[2] in 1831 said of the *Polemoniaceae* that their properties were none or unknown. According to Culbreth[3], *Phlox carolina* is allied to Spigelia and is a good anthelmintic, as is

[1] Solereder, H. Systematische Anatomie der Dicotyledonen, p. 622, 1899.
[2] Lindley, John. Introduction to the Natural System of Botany, p. 216, 1831
[3] Culbreth, D. M. Materia Medica and Pharmacology, p. 448, 1900.

likewise *Phlox glaberrima.* It has not been possible, however, to verify the source of this information.

In the Maisch collection of crude drugs is a sample received from Sparta, Ga., in 1883, which bears the label "*Phlox glaberrima* Lin., sold as Pink Root." Examination revealed that the roots were neither Phlox nor Ruellia. It has been suggested that *Phlox ovata* was used as an anthelmintic before Spigelia was adopted, and since pinkroot has been regarded as being sometimes replaced by *Phlox glaberrima*, the inference was probable that the latter was a good anthelmintic. Until some careful investigations shall have determined the properties of *Phlox glaberrima*, it, as well as *Phlox ovata*, can not be regarded as possessing any medicinal value, and must be omitted from the category of medicinal plants.

IMPURITIES.

The roots of the following plants sometimes occur intermingled with those of Spigelia, but are impurities rather than adulterants. As has been suggested, these may be introduced accidentally in the drug lofts, or through carelessness on the part of the collector. Upon consideration of the fact that some of these roots, such as serpentaria or goldenseal, are themselves usually worth from three to five times as much as Spigelia, it does not seem that they would knowingly be introduced as an adulterant of pinkroot.

Saponaria officinalis L. Hagen[1] says that *Saponaria officinalis* L. sometimes takes the place of Spigelia in the markets, but that it may be distinguished by its three-nerved leaves. This plant scarcely deserves mention as an adulterant of Spigelia, since it rarely, if ever, occurs in American markets; but if present it may be readily distinguished from the true pinkroot by the greater size of the root and the general habit of growth, which do not at all resemble Spigelia.

Aristolochia serpentaria L. Serpentaria is indicated by numerous modern materia medicas as possibly confused at times with Spigelia, from which, however, it may be readily distinguished. The pith of the rhizome is eccentric, being nearest the upper side, while broad medullary rays separate the wood into prominent wedges. The

[1] Hagen, cited by Berg. Pharmakognosie des Pflanzen- und Thierreichs, pp. 263—264, Berlin, 1879.

odor is aromatic, resembling that of turpentine, and is alone sufficient to distinguish the plant from pinkroot.

Hydrastis canadensis L. The root of goldenseal (*Hydrastis canadensis* L.) has been reported as an adulterant of Spigelia, but not to any great extent. As much as 6 per cent has been detected. The yellow rootlets and the large rhizome with lemon-yellow interior serve to distinguish it readily.

Dioscorea villosa L., wild yam root; and *Collinsonia canadensis* L., stone root, sometimes occur as impurities, but may be easily detected, usually, by their well-known gross structure and general appearance.

MICROSCOPIC EXAMINATION OF SPIGELIA AND ADULTERANTS.

Ruellia is the only important adulterant found in Spigelia, since the other plant parts sometimes present occur almost wholly as impurities. On this account a simple preliminary examination may serve to show the character of material offered as pinkroot, since Ruellia differs very markedly in appearance from Spigelia and is easily separated from it. If unground roots or rhizomes are to be examined they should be placed for a time in water to soften the tissues and render them less refractory to the knife in cutting. Thin sections cut with a sharp scalpel or section razor may be floated out on a drop of water on a glass slide and readily examined with a microscope or good hand lens. A comparison of the structures observed with those of Spigelia, Ruellia, and Phlox (see Figs. 4—9, 11—18) will readily serve to identify the section. The structures under observation may be rendered more distinct by the use of zinc chloro-iodid. When the application of a drop of this reagent to the section is followed by the development of an intense blue color, particularly in the pith of the rhizome, Spigelia is indicated. If no blue color appears and large stone cells and cystoliths are seen in the cells of the cortex the material is Ruellia. Since other roots or rhizomes are also said to occur mixed with Spigelia, from which close examination may be required to distinguish them in materials purporting to be pinkroot, the following key is offered for their separation:

Cystoliths present .... Ruellia.
Cystoliths wanting.
  Starch present .... Spigelia.
  Starch wanting.
    Corky layer 1-3 cells thick or wanting............. Phlox.
    Corky layer 3 to many cells thick............. Saponaria.

A differentiating character is presented, however, by the starch grains, since starch is absent from the adulterants mentioned above. However, the fineness of the starch grain and its lack of striking characters render uncertain its identification among many other plant starches which might be readily introduced in the powdered drug. These starch grains measure about 4 μ and in powdered pinkroot are associated with parenchyma cells and long, light-colored sclerenchyma fibers. Ruellia always reveals its presence by the numerous stone cells and cystoliths which frequently remain intact even in finely powdered material. Powdered samples of the underground portions of the Phlox at hand gave no reaction for starch. The absence of starch from a powder supposedly made of pinkroot suggests at once that the material is not Spigelia. On the other hand, the presence of starch while indicative of Spigelia is by no means conclusive of its presence.

Users of pinkroot can best secure a pure article by purchasing the crude drug and subjecting it to a rigid examination, using the microscope when necessary to verify all doubtful material until the gross characters are well enough learned to permit accurate determination by observing the macroscopic character of the roots.

COMMERCIAL ASPECTS OF PINKROOT.

Although pinkroot occurs over a wide area in the eastern half of the United States, it is not now found north of Virginia and Kentucky in sufficient abundance to make profitable its collection as a drug root. Since its introduction to the settlers of the Carolinas as a vermifuge it has been regarded as a plant belonging essentially to the Southern States. Its special properties caused it to be sought for and collected by the Indians who early inhabited this region, especially the Creeks and Cherokees of Georgia. When pinkroot first came into use the entire plant was employed. This was pulled up by the Indians and after being dried was packed in bales and bartered to the whites. As the settlers pushed westward, new fields of supply opened in the region adjacent to the Mississippi River. For many years the States east of that river furnished practically all the pinkroot that entered the market, but under the stimulus of the high prices obtainable in 1862-3 new sources of supply were opened in Arkansas and now the Southwestern States produce a large part of the drug annually sent into commerce at New Orleans and St. Louis.

The method of collection has changed somewhat with time, and now there is collected the official part only, consisting of rhizome and roots. These, after being freed from dirt as much as possible, are carefully dried and packed in bales or casks for shipment to the market. Pinkroot that has been thoroughly dried and then packed in casks has frequently been preferred to the root put up in bales, since the casks not only protect the root from dampness, which of itself causes deterioration in quality, but also largely diminish the tendency to mold, which is frequent in bales that have become damp. Formerly, when space was not so valuable in storage and shipment, crude drugs were sent into commerce packed in flour barrels or made up in loose bales. Now an effort is made to compact the material as much as possible, and some collectors of crude drugs utilize the cotton presses readily accessible to almost every southern farmer to compress

drug leaves or roots into firm bales. This treatment saves in the cost of handling and storing and also by tending to exclude the air from the bales reduces the absorption of moisture and consequent deterioration.

Market quotations show that the demand for pinkroot, though quiet, is steady, and prices from year to year show only fluctuations consistent with the general movement of crude drug prices. The highest price recorded for pinkroot was reached in 1862-3, when it sold for $3.25 per pound, quality receiving scant consideration so long as the material could be called pinkroot. It was reported as the scarcest of all drugs in 1863, the lack of supply and consequent high prices probably being due to the interruption of trade incident to the hostilities between the North and the South. In the latter part of 1863 the price per pound declined to $1.50, and 1864 saw a further decline to $1.25, with the supply small and the quality only fair. By August, 1870, the price had fallen to 30 cents, but rose again the next year to 50 cents, dropping back in 1872 to 38 or 40 cents a pound. Prices in 1874 were a little higher, due possibly to the financial panic of the previous year which decreased the volume of business and caused a severe shrinkage in the quantity of crude drugs entering the market. In 1886-7 prices had risen to 40 to 50 cents, and in 1895 they had declined to 18 to 27 cents a pound. According to the Oil, Paint and Drug Reporter, the range of prices of pinkroot for the decade ending with 1904, was from a maximum of 27 cents in 1895 to a minimum of 17 cents reached in 1903 and again in 1904. In November, 1905, the price advanced to 45 cents, and in June, 1906, the price was quoted at $1.00 to $1.25 per pound.

The market supply of pinkroot, in common with other crude drugs, is variable, since the greater number of collectors do not make a regular business of gathering drugs, but take up the work when otherwise unemployed or when prices have become attractive. Prices naturally accomodate themselves to the supply, and a season of vigorous collecting is apt to be followed by a declining market. This in turn tends to diminish collection and causes a shrinkage in supply, which is in turn followed by increasing prices as the demand quickens.

In the widespread adulteration of crude drugs, to which pinkroot forms no exception, lies a factor which undoubtedly has a marked effect on the market price. In many cases the presence of the adul-

terant has been recognized and due allowance made for it in determining the quality of pinkroot. However, the fact that Ruellia has so far supplanted the real drug as to be studied and described as pinkroot shows that in the majority of cases in which the adulterant was present it has been undetected. When this fact is recognized it no longer appears strange that Spigelia has been credited with being a drug of very uncertain and variable action. In hundreds of cases in which pinkroot has been prescribed, an extract of Ruellia has in reality been given and the results of its action—good or bad—have been attributed to Spigelia. Fortunately, Ruellia apparently possesses no properties which in the doses usually administered give very marked physiological action. The menace, however, to the well-being of the patient by the use of adulterated drugs is a double one, for not only is he deprived of the remedy which is indicated in his peculiar ailment, but there are administered to him plant principles with the nature and action of which neither physician nor patient may be familiar.

The rigid exclusion of adulterated or false pinkroot from the markets may operate to further increase the price, which is now abnormally high. However, the effectiveness of the drug as a whole should thereby be so increased that the result would be a distinct economic gain.

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BIBLIOGRAPHY.

ABBOT, HELEN, and TRIMBLE, H. On the occurrence of solid hydrocarbons in plants. Amer. Jour. Pharm., 60:321-324, 1888.

ADANSON, MICHEL. Familles des plantes, p. 223, Paris, 1763.

AINSLEE, WHITELAW. Materia Indica, vol. 2, p. 153 London, 1826.

AITON, WM. Hortus Kewensis, vol. 1, p. 202, London, 1789.

ALLEN, T. F. The encyclopedia of pure materia medica, vol. 9, p. 94, New York, 1877.

AMERICAN DRUGGIST, 18:32, Feb., 1889.

AUBLET, J. B. C. F. Histoire des plantes de la Guiane Française, vol. 1, p. 126, London and Paris, 1775.

BAILEY, L. H. Cyclopedia of American horticulture, vol. 4, p. 1698, New York, 1902.

BAILLON, H. Histoire des plantes, vol. 9, p. 345, Paris, 1888; vol. 10, p. 421, Paris, 1891.

——— Dictionnaire de botanique, vol. 4, p. 99, Paris, 1892.

BALLARD and GARROD. Elements of materia medica, p. 334, London, 1846.

BARTHOLOW, R. A practical treatise on materia medica and therapeutics, ed. 5, p. 657, New York, 1884.

BARTON, BENJ. S. Collections for an essay towards a materia medica of the United States, p. 39, Philadelphia, 1798; ed. 3, pp. 38-39, 1810.

——— On the beneficial effects of the Datura stramonium, on the Spigelia marilandica, and on vermifuge medicines. Med. and Phys. Jour., 8:426-430, 1802.

——— Cullen's treatise of the materia medica, vol. 2, p. 413, Philadelphia, 1812.

BARTON, WM. P. C. Vegetable materia medica, vol. 2, p. 75, Philadelphia, 1817.

——— Podrome of a work to aid the teaching of the vegetable materia medica, pp. 33, 78, Philadelphia, 1833.

BATES and TILDEN. The journal of materia medica, vol. 2, pp. 277, 383, New Lebanon, N. Y., 1860.

BEACH, W. The American practice of medicine, vol. 3, p. 164, New York, 1833.

——— The American practice condensed, ed. 14, p. 673, New York, 1848.

BEASLEY, H. The pocket formulary, ed. 9, p. 152, Philadelphia, 1872.

——— The druggists' general receipt book, ed. 9, p. 195, Philadelphia, 1886.

BECK, L. C. Botany of Northern and Middle States, p. 238, Albany, 1833.

BELL, JOHN. Practical dictionary of materia medica, p. 433, Philadelphia, 1841.

BENTHAM, GEORGE. Notes on Loganiaceae. Jour. Linn. Soc., Botany, 1:90, London, 1857.

——— and HOOKER. Genera plantarum. 2:790, London, 1862-83.

BENTLEY, ROBERT. A manual of botany, p. 597, London, 1882.

——— and TRIMEN. Medicinal plants, vol. 3, No. 180, London, 1880.

BERG, OTTO. Handbuch der pharmaceutischen Botanik, p. 224, Berlin, 1845.

——— Pharmazeutische Botanik, p. 265, Berlin, 1866.

——— Pharmakognosie des Pflanzen- und Thierreichs, pp. 93, 263-264, Berlin, 1879.

BERGIUS, P. J. Materia medica e regno vegetabili, vol. 1, pp. 93-95, Stockholm., 1778.

BIGELOW, J. American medical botany, vol. 1, p. 112, Boston, 1817.

BLACKIE, GEORGE S. Contributions to the medical flora of Nashville. Nashville Jour. Medicine and Surgery, 19:193, 1860.

BOCQUILLON-LIMOUSIN, H. Manuel des plantes médicinales, pp. 241, 263, Paris, 1905.

BONYUN. On Spigelia anthelmia. Pharm. Jour., 5:354, 1845-6.

BOORSMA, W. G. Nadere resultaten van het door Dr. W. G. Boorsma verrichte onderzoek naar de plantenstoffen. Mededeelingen uit Buitenzorg's lands plantentuin, 18:5-17, 1896.

BOTANICAL MAGAZINE, 3:Pl. 80, London, 1790.

BOULGER, G. S. The uses of plants, p. 105, London, 1889.

BOYNTON, WM. C. Laboratory notes. Amer. Jour. Pharm., 56:570, 1884.

BRANNER, J. C., and COVILLE, F. V. A list of the plants of Arkansas. Annual Report, Geol. Survey, Arkansas, vol. 4, par. 2, p. 201, 1888.

BROCKLESBY, RICHARD. Oeconomical and medical observations, pp. 282-285, London, 1764.

BROWN, O. P. The complete herbalist, p. 195, Jersey City, 1867.

BROWNE, PATRICK. Account of the Anthelmia or Spigelia Linnaei, its properties and use. Gentleman's Magazine, 21:514-516, London, 1751. The Medical Museum, 1:221-224, London, 1763.

——— The civil and natural history of Jamaica, p. 156, London, 1756.

BUCHAN, W. Domestic medicine, p. 608, Boston, 1825.

BULLETIN des sciences médicale de Ferussac, 9:301.

BUREAU, LOUIS ED. De la famille des Loganiacées et des plantes qu'elle fournit à la médicine. Thèse Fac. méd., Paris, 1856.

CARSON, J. Illustrations of medical botany, vol. 2, p. 9, Philadelphia, 1847.

CATESBY, M. The natural history of Carolina, Florida, and the Bahama Islands, vol. 2, p. 78, London, 1743.

CHALMERS. An account of the weather and diseases at South Carolina, vol. 1, p. 67, London, 1776.

CHAPMAN. Elements of therapeutics and materia medica. Philadelphia, 1825.

CHEREAU, A. Rapport sur la journal de pharmacie de Philadelphia, April, 1832. Journ. de Pharm. et des Sci. Acces., 18:463, Paris, 1832.

CLAPP, A. A synopsis, or systematic catalogue, of the medicinal plants of the United States, p. 104, Philadelphia, 1852. Trans. Amer. Med. Assoc., 5:687-906, 1852.

CLARK, J. Remarks on the efficacy of Spigelia anthelmia in worm cases. Medical Facts, 7:297, London, 1796.

COLLIANDER, J. G. Dissertatio medica de Spigelia anthelmia. Amoenitates Academicæ, 5:133-147, 1758.

CORRE and LEJANNE. Résumé de la matière médicale et toxologique coloniale, pp. 46, 124, Paris, 1887.

COULTER, J. M. Botany of western Texas. Contrib. U. S. Nat. Herbarium, 2:271, 1891-94.

COURCHET, L. Traité de botanique, vol. 2, p. 1187, Paris, 1898.

CRANTZ, H. I. Institutiones rei herbariæ, vol. 2, p. 322, Vienna, 1766.

CULBRETH, D. M. R. Materia medica and pharmacology, pp. 447-448, Philadelphia, 1900.

CURRIE. Some accounts of the deleterious effects of the Spigelia marilandica or Carolina pinkroot in two cases. Phila. Med. and Phys. Jour., vol. 1, par. 2, p. 74, 1805.

CURTIS, M. A. Catalogue of the indigenous and naturalized plants of North Carolina. Geol. and Nat. Hist. Survey of Carolina, par. 3, p. 26, 1867.

CURTIS'S Botanical Magazine, vol. 50, pl. 2359, 1823.

DANCER, THOS. The medical assistant: or Jamaica practice of physic, p. 391, St. Jago de la Vega, 1809.

DARBY, JOHN. Botany of the Southern States, p. 435, New York, 1855.

DARLINGTON, WM. American weeds and useful plants, p. 165, New York, 1859.

Datos para la materia medica Mexicana, primera parte, p. 251, Mexico, 1894.

DE CANDOLLE, A. P. Essai sur les propriétés médicales des plantes, p. 217, Paris, 1816.

——— Prodromi systematis naturalis, etc., vol. 9, p. 5, Paris, 1845.

DECHAMBRE, A. Dictionnaire encyclopédique des sciences médicales, sér. 3, 5:583, 1877; 11:219-223, Paris, 1883.

DESPORTES, M. Traité abrégé des plantes usuelles de Saint Dominique, vol. 3, p. 111, Paris, 1770.

DETHAN, G. Des acanthacées médicinales, pp. 80-88, Thèse, Paris, 1896.

DEWEES, WM. P. A treatise on the physical and medical treatment of children, pp. 456, 460-461, Philadelphia, 1825.

DIETRICH, D. Synopsis plantarum, vol. 1, p. 681, 1839.

DON, GEORGE. A general history of dichlamydeous plants, pp. 170-171, London, 1838.

DONN, JAS. Hortus cantabrigiensis, ed. 3, p. 30, Cambridge, 1804.

DRAGENDORFF, G. Die Heilpflanzen, p. 532, Stuttgart, 1899.

DRAYTON, J. A view of South Carolina as respects her natural and civil concerns, p. 63, Charleston, 1802.

DUCHESNE, E. A. Répertoire des plantes utiles et des plantes vénéneuses, p. 107, Paris, 1836.

DUDLEY, W. L. Preliminary notice of a new volatile alkaloid. Amer. Chem. Journ., 1:154-155, 1879-80.

DUJARDIN-BEAUMETZ and ÉGASSE. Les plantes médicinales indigène et exotiques, pp. 682-684, Paris, 1889.

DU MONT DE COURSET, G. L. M. Le botaniste cultivateur, ed. 2, vol. 3, p. 260, Paris, 1811.

DUNCAN, A. The Edinburgh new dispensary, pp. 307, 347, Worcester, 1805.

——— Catalogue of medicinal plants, p. 17, Edinburgh, 1826.

EATON, A. Manual of botany, p. 471, Albany, 1824.

EBERLE, JOHN. Materia medica and therapeutics, vol. 1, p. 214, Philadelphia, 1834.

EGGERS, H. F. The flora of St. Croix and the Virgin Islands, p. 60, Washington, 1879 (U. S. Nat. Museum Bul. No. 13).

ELLIOT, S. Sketch of the botany of South Carolina and Georgia, vol. 1, p. 236, Charleston, 1821.

ENGLER and PRANTL. Die natürlichen Pflanzenfamilien, Theil 4, Abt. 2, p. 33, 1892.

ERNST, A. Plants used medicinally at Caracas, Venezuela, S. A., and their vernacular names. Journal of Botany, 3:310, 1865.

EWELL, J. The medical companion, ed. 5, p. 605, Philadelphia, 1819.

FEATHERMAN, A. Report of the botanical survey of southern and central Louisiana, New Orleans, 1871.

FENEULLE, H. Analyse de la Spigélie anthelminthique. Jour. de Pharm. et Sci. Access., sér. 2, 5:197, Paris, 1823.

FLUCKIGER and HANBURY. Histoire des drogues d'origine végétale, vol. 2, p. 90, Paris, 1878.

——— Pharmacographia, p. 433, London, 1879.

FREE, J. E. Pinkroot poisoning. Med. and Surg. Reporter, 70:633, 1894.

FREEMAN, W. G. Notes from Barbadoes. Pharm. Jour. and Trans., 67:615, 1901.

FROST, H. R. Outlines of a course of lectures on the materia medica, ed. 4, p. 84, Charleston, 1851.

GARDEN, ALEX. An account of the Indian pink. Ess. and Obs. Phys. and Lit., 3:145-153, Edinburgh, 1771.

GARDNER, JOHN. Household medicine, ed. 8, pp. 346, 440, London, 1873.

GATTINGER, A. Medicinal plants of Tennessee, p. 54, Nashville, 1894.

GMELIN, L. Handbook of chemistry, English translation by Watts, vol. 18, p. 242, London, 1848-72.

GOOD, P. Family flora and materia medica botanica, vol. 2, No. 61, Elizabethtown, 1845.

GOSS, I. J. M. Text-book of materia medica, pharmacology, and special therapeutics, pp. 453-455, Chicago, 1889.

GRAINGER, J. An essay on West Indian diseases, ed. 2, p. 28, Edinburgh, 1802.

GRANT, W. T. Indigenous medicinal plants. Confederate States Medical and Surgical Journal, 1:84-86, Richmond, 1864.

GREEN, H. American medical monthly, p. 176, 1858.

GREENISH, H. C. Note on Phlox carolina. Pharm. Jour. and Trans., ser. 3, 21:839, 1891.

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GRIESEBACH, A. Flora of the British West Indian Islands. p. 33. London. 1864.

GRIFFITH, R. E. On Spigelia marilandica. Jour. Phila. Coll. Pharm., 4. art. 1, 1832.

——— Medical botany, p. 466, Philadelphia, 1847.

GRONOVIUS, J. F. Flora Virginica, ed. 2. p. 30, Leyden. 1762.

GUIBOURT, N. J. Histoire des drogues simples, ed. 6. vol. 2. pp. 551-552. Paris, 1869.

HAGEN, R. Therapeutisches Taschenbuch der Kinderkrankheiten. pp. 43, 60, Leipzig, 1861.

HAHNEMANN, S. Materia medica pura, vol. 4, pp. 119-142. London, 1846.

HALE, J. Report on the medical botany of the State of Louisiana. New Orleans Med. and Surg. Jour., 9:167, 1853.

HAMILTON, E. The flora homœopathica, vol. 2, p. 181. London, 1852-3.

HAMILTON, J. Culpper's English family physician or medical herbal, vol. 2, p. 344. London, 1792.

HAND, W. M. The house surgeon and physician, p. 184. Hartford, 1818.

HARE, H. A. The physiological action of Spigelia or pinkroot. Medical News, 50:286, 1887.

HARTWICH, CARL. Die neuen Arzneidrogen, p. 252. Berlin, 1897.

HEMSLEY, W. B. Biologia Centrali-Americana: Botany, vol. 2, p. 339. London, 1881-8.

HENRY, S. American medical family herbal, pp. 166-167, New York. 1814.

HÉRAIL, J. Recherches sur l'anatomie comparée de la tige des dicotylédones. Ann. Sci. Nat. Bot., sér. 7, 2:203-314, 1885.

HERNANDEZ, F. Rerum medicarum novæ Hispaniæ thesaurus, p. 201, Rome, 1651.

HOLLEMBAEK, H. American eclectic materia medica, pp. 367-369. Philadelphia, 1865.

HOME, F. Clinical experiments, histories, and dissections, p. 420. Edinburgh, 1780.

HOWARD, H. An improved system of botanic medicine. vol. 2, p. 28. Columbus, 1833.

HUGHES, G. The natural history of Barbadoes, p. 230, 1750.

HUMBOLDT, A. Nova genera et species plantarum, vol. 3, p. 185, Paris, 1818.

HYAMS, M. E. The crude drug industry of the South. Pharm. Era, 4:12-15, January, 1890.

Icones plantarum medicinalium, Cent. 5, tab. 469. Nuremberg, 1784.

JOHNSON, L. Manual of medical botany of North America, New York. 1884.

JOHNSON, G. W. Gardener's dictionary, new ed., p. 920. London. 1894.

JUSSIEU, A. DE. Genera plantarum, p. 143, Paris, 1789.

KARSTEN, H. Deutsch Flora: pharmaceutisch-medicinische Botanik. p. 1039, Berlin, 1883.

KNOWLTON, F. H. The Loganiaceæ. Merck's Report, 10:363. 1901.

KOST, J. Elements of materia medica and therapeutics, new ed., pp. 355-356, Cincinnati, 1858.

——— Domestic medicine, pp. 355-356, Cincinnati, 1859.

KOSTELETZKY, V. F. Allgemeine medizinisch-pharmazeutische Flora, vol. 3, p. 1051, Prague, 1834.

KUNTZE, O. Revisio generum plantarum, vol. 2, p. 425, Leipzig, 1891.

LE MAOUT and DECAISNE. Traité général de botanique, p. 163, Paris, 1868.

LEWIS, WM. An experimental history of the materia medica, vol. 2, p. 377, London, 1791.

LINDLEY, JOHN. Introduction to the natural system of botany, pp. 215-216, New York, 1831.

——— Flora medica, p. 524, London, 1838.

LINING, JOHN. Of the anthelmintic virtues of the root of the Indian pink. Ess. and Obs. Phys. and Lit., 1:386-389, Edinburgh, 1754.

LINK, H. F. Enumeratio plantarum horti regii botanici Berolinensis, p. 208, Berlin, 1821.

LINNAEUS, C. Systema naturae, ed. 2, p. 25, 1747.

——— Species plantarum, vol. 1, p. 149, Stockholm, 1753.

——— Amoenitates academicae, ed. 2, vol. 5, pp. 139-147, Erlangen, 1758.

——— Systema naturae, ed. 12, vol. 2, pp. 166, 734, Stockholm, 1767.

——— Mantissa plantarum, p. 338, Stockholm, 1771.

——— Materia medica, p. 59, Leipzig and Erlangen, 1772.

LODDIGES, C. Botanical cabinet, vol. 10, pl. 930, London, 1812-33.

LOEFLING, PETER. Iter Hispanicum eller resa till spanska länderna uti Europa och America, p. 212, Stockholm, 1758.

LUERSSEN, C. Medicinisch-pharmaceutische Botanik, vol. 2, p. 1059, Leipzig, 1879.

LUNAN, J. Hortus Jamaicensis, vol. 2, pp. 305-306, Jamaica, 1814.

MAISCH, JOHN M. Minutes of the pharmaceutical meeting, Philadelphia, November 20, 1883. Amer. Jour. Pharm., 55:631-632, 1883; Pharm. Jour., ser. 3, 14:779, 1884.

——— Manual of organic materia medica, ed. 6, p. 129, Philadelphia, 1895.

MARCGRAF, G. Historiae rerum naturalium, p. 34, Leyden and Amsterdam, 1648.

MARTIUS, K. F. P. Nova genera et species plantarum Brasiliensium, vol. 2, pp. 128-135, Munich, 1826.

——— Systema materiae medicae vegetabilis Brasiliensis, p. 70, Leipzig, 1843.

——— Flora Brasiliensis, vol. 6, pp. 262, 295, Munich, 1860-68.

Medical botany or history of plants in the materia medica, vol. 1, p. 31, London, 1821.

MÉRAT and DE LENS. Dictionnaire universel de matière médicale, vol. 4, pp. 276, 278, Paris, 1837.

MICHAUX, A. Flora boreali-americana, vol. 1, p. 147, Paris, 1820.

MILLER, A. W., MERCEIN, J. R., and PEIXOTTO, M. Report of the committee on adulterations and sophistications. Proc. Amer. Pharm. Assoc., 23:509, 1875.

MILLER, P. Gardener's dictionary, ed. 7, London, 1759; ed. 8, 1768.
——— Gardener's and botanist's dictionary, vol. 2, London, 1807.
MILLSPAUGH, C. F. American medicinal plants, vol. 2, p. 131, New York and Philadelphia, 1887.
MITCHELL, THOS. D. Materia medica and therapeutics, p. 759, Philadelphia, 1857.
MOHR, C. T. Medicinal plants of Alabama, p. 12, Mobile, (1893 ?).
——— Plant life of Alabama. Contrib. U. S. Nat. Herbarium, vol. 6, p. 669, Washington, 1901.
MONROE, D. A treatise on medical and pharmaceutical chymistry, vol. 3, p. 270, London, 1788.
MOQUIN-TANDON, A. Éléments de botanique médicale, p. 44, Paris, 1866.
MORELLE, E. Histologie comparée des Gelsemiées et Spigeliées. Univ. Paris, École de Pharm., Thèse, 1904.
MURRAY, J. A. Apparatus medicaminum, vol. 1, pp. 378, 380, Goettingen, 1776-92.
——— System of materia medica and pharmacy, p. 278, New York, 1824.

NECKER, N. J. DE. Elementa botanica, vol. 2, p. 37, 1791.
NEES VON ESENBECK, T. F. L. Plantæ medicinales, Bd. 1, Lief. 5, Consp. 205, Düsseldorf, 1828.
——— Handbuch der medicinisch-pharmaceutischen Botanik, vol. 2, p. 654, Düsseldorf, 1831.
NELIGAN, J. M. Medicines, their uses and mode of administration, ed. 3, p. 29, Dublin, 1851.
NICHOLSON, G. Dictionary of gardening, vol. 3, p. 472, New York, 1887.
NOVERRE, M. Mémoire sur la spigéle anthelmintique ou à la Brinvilliers. Jour. hebd. de Progrès de Sci., 1: 373, Paris, 1834.
Nueva Farmacopea Mexicana, ed. 3, p. 94, Mexico, 1896.
NUTTALL, THOS. Genera of North American plants, vol. 1, p. 134, Philadelphia, 1818.

O'CONNER, J. T. American homœopathic pharmacopœia, ed. 5, p. 417, Philadelphia, 1896.

PAINE, M. Therapeutic arrangement of the materia medica, p. 236, New York, 1842.
PEREIRA, J. Elements of materia medica, part 2, p. 901, London, 1840.
——— Elements of materia medica and therapeutics, Am. ed. 3, vol. 2, pp. 530, 532, Philadelphia, 1854.
PERROT. Le tissu criblé. Thèse agrég. École Pharm., Paris, pp. 161-173, 1899.
PERSOON, C. H. Synopsis plantarum, vol. 1, p. 281, Paris, 1805.
PETIVER, J. Gazophylacii naturæ et artis decades X, tab. 59, London, 1702-1709.
PITTIER, H. Primitiæ floræ Costaricensis, vol. 2, p. 164, San José de Costa Rica, 1898-1900.
PLENCK, M. Pharmacologie chirurgicale, p. 237, Paris, 1786.
PLUMIER, C. Nova plantarum Americanarum, Genera, p. 11, Paris, 1703.
POIRET, J. L. M. Encyclopédie méthodique, vol. 7, p. 344, Paris, 1806.

PORCHER, F. P. Report on the indigenous medicinal plants of South Carolina. Trans. Amer. Med. Assoc., 2:825, Philadelphia, 1849.

——— Resources of the southern fields and forests, p. 481, Charleston, 1869.

PURSH, F. Flora americæ septentrionalis, vol. 1, p. 139, London 1814.

RAFINESQUE, C. S. Medical flora of the United States, vol. 2, p. 89, Philadelphia, 1830.

RAMIREZ, JOSÉ. Sinonima vulgar y cientifica de les plantas mexicanas, Mexico, 1902.

RAY, JOHN. Historiæ plantarum, vol. 3, Dendrologiæ, p. 32, London, 1704.

REES, A. Cyclopædia of arts, sciences, and literature, vol. 33, London, 1819.

RICORD MADIANA, J. B. Recherches et expériences sur les poisons d'Amérique. Premier Mémoire du Brinvilliers, Bordeaux, 1826.

ROCHLEDER, F. Phytochemie, p. 141, Leipzig, 1854.

ROEMER and SCHULTES. Systema vegetabilum, vol. 4, p. 190, Stuttgart, 1819.

RUFZ, E. Recherches sur les empoisonnemens practiqués pas les nègres à la Martinique, Paris, 1844.

RUIZ and PAVON. Flora Peruviana et Chilensis, vol. 2, p. 1799.

RUSH, BENJ. Medical inquiries and observations, p. 160, Philadelphia, 1789.

SARGENT, C. S. Portions of the journal of André Michaux. 1785-1796. Proc. Amer. Phil. Soc., 26:121, 1889.

SAUNDERS, WM. Report of the committee on the drug market for 1877. Proc. Amer. Pharm. Assoc., 24:342, 1877.

SCHLECHTENDAL, D. F. L., VON. Linnaea, 1:201, Berlin, 1826.

SCHLEIDEN, M. J. Handbuch der medicinisch pharmaceutischen Botanik, vol. 2, p. 651, 1831.

——— Handbuch der botanischen Pharmacognosie, p. 42, Leipzig, 1857.

SCHLEIF, WM. Materia medica, therapeutics, etc., p. 242, Philadelphia, 1899.

SCHNEIDER, A. Powdered vegetable drugs, pp. 101, 297, Pittsburg, 1902.

SCHOEPF, J. D. Materia medica americana, Erlangen, 1787.

SOLLREDER, H. Ueber systematischen Werth der Holzstructur. Inaug. Diss., Munich, 1885.

——— Systematische Anatomie der Dicotyledonen, p. 696, Stuttgart, 1899.

SPALSBURY, G. W. Unusual effects from the use of the Spigelia marilandica. Boston Med. and Surg. Jour., p. 72, April, 1855.

SPRENGEL, KURT. Histoire de la médecine depuis son origin, vol. 4, p. 431; vol. 5, pp. 491-495, Paris, 1815.

STABLER, R. H. On Spigelia. Proc. Amer. Pharm. Assoc., 6:132, 1857.

STAHL, A. Estudios para la flora de Puerto-Rico, vol. 5, p. 54, Puerto-Rico, 1884-88.

STEARNS, S. American herbal; or, materia medica, p. 259, Walpole, 1801.

STEPHENSON and CHURCHILL. Medical botany, vol. 1, No. VII, London, 1831.

STILLÉ, A. Therapeutics and materia medica, ed. 3, vol. 2, p. 650, Philadelphia, 1868.

THACHER, J. American new dispensatory, ed. 3, p. 362, Boston, 1817.

THOMPSON, H. Experimental dissertation on the Spigelia marilandica or Indian pink, Philadelphia, 1802.

TORREY, J. Flora of the northern and middle sections of the United States, vol. 1, p. 222, New York, 1824.

TRIMBLE, H. An analysis of the underground portion of Phlox carolina. Amer. Jour. Pharm., 58:479-481, 1886. See also Proc. Amer. Pharm. Assoc., 34:118, 1886.

TRUE, R. H. East Tennessee pinkroot. Pharm. Rev., 21:364, 1903.

TUSSAC, F. R. DE. Flore des Antilles, vol. 4, p. 27, Paris, 1827.

U. S. Dispensatory, ed. 18, p. 1265, Philadelphia, 1899.

VESQUE, J. Mémoire sur l'anatomie comparé de l'écorce. Ann. Sci. Nat. Bot., sér. 6, vol. 2, pp. 82-198, 1875.

VOGEL, R. A. Historia materiæ medicæ ad novissima tempora producta, p. 216, Frankfort and Leipzig, 1760.

WACKENRODER, H. G. F. De anthelminthicis, p. 52, Göttingen, 1826.

WAILES, B. L. Report on the agriculture and geology of Mississippi, part 7, p. 347, 1854.

WALTER, THOS. Flora Caroliniana, p. 92, London, 1788.

WEATHERS, J. W. Guide to garden plants, p. 649, New York and Bombay, 1901.

WHYTE, ROBT. Observations on the nature, causes, and cure of nervous disorders, etc., ed. 2, p. 409, Edinburgh, 1765.

WILLDENOW, C. L. Species plantarum, vol. 1, pt. 2, p. 825, Berlin, 1797.

WINKLER, E. Real-Lexicon, vol. 2, p. 684, Leipzig, 1842.

WOOD A. Class-book of botany, ed. 41, p. 308, Troy, 1846.

——— American botanist and florist, p. 269, New York, 1870.

WOOD, H. C. A treatise on therapeutics, p. 516, Philadelphia, 1874.

WOODVILLE and HOOKER. Medical botany, ed. 3, vol. 1, pp. 178-181, London, 1832.

WRIGHT, WM. An account of the medicinal plants growing in Jamaica. London Med. Jour., 8:285, 1787.

PRODUCTION OF DRUG-PLANT CROPS IN THE UNITED STATES

BY

W. W. STOCKBERGER
Physiologist in Charge of Drug-Plant and Poisonous-Plant Investigations, Bureau of Plant Industry

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PRODUCTION OF DRUG-PLANT CROPS IN THE UNITED STATES.

By W. W. Stockberger,

Physiologist in Charge of Drug-Plant and Poisonous-Plant Investigations, Bureau of Plant Industry.

MEDICINAL plants have been cultivated in the United States for more than two centuries. Only a few decades have elapsed since healing herbs shared with small fruits and vegetables a place in every kitchen garden, and in certain localities their production and sale at one time formed the basis of small industries. In time, however, the numerous convenient preparations obtainable at every drug store rendered the domestic herb garden no longer necessary, and the great development of foreign commerce made it possible to obtain supplies of most crude drugs from sources where the cost of production was less than in this country. As a result, drug cultivation has never become an important branch of agriculture in the United States, and in recent years it has been confined chiefly to the production of relatively small crops of plants yielding volatile oils which are in demand for industrial purposes as well as for medicinal use.

DRUG CRISIS PRECIPITATED BY THE WAR.

The extent to which this country had become dependent upon foreign sources for its supply of crude drugs was not generally realized until 1914, when the war in Europe abruptly severed long-established trade connections and either greatly reduced or cut off entirely our supplies of many drugs. Prices rose to almost unheard-of figures, and the fear of a drug famine occasioned grave concern in business circles interested in maintaining the supply of medicinal products. The crude-drug situation soon became a popular subject for feature stories in numerous magazines and newspapers, and many people have been led to believe that the cultivation of medicinal plants offers unusual opportunities for large profits.

DRUG PLANTS CULTIVATED IN THE UNITED STATES.

Although the list of plants which yield useful drugs is large, the number at all suitable for cultivation in this country is relatively small. Many crude drugs are derived from plants which thrive only in the Tropics and therefore can not be successfully grown in the United States. Many other drugs are obtained from native trees and shrubs, and from wild herbs, some of which grow naturally on sandy or stony soil in the woodland shade, some in swamps and marshy places, while others occur as familiar weeds along roadsides, in meadows, and in open woods. When these wild plants are taken from their natural surroundings and placed under the conditions which exist in cultivated fields, they very frequently fail to make a satisfactory growth and often become the prey of insects or diseases from which they are practically free when in their native haunts. To domesticate these wild plants is by no means a simple task; it requires much time and patience, as well as unusual skill both in handling the plants and in supplying the conditions necessary for their favorable growth and development.

Many of the common medicinal plants are still grown in gardens in this country, either as decorative plants or for domestic use in cookery and as home remedies. For the most part, however, the consumption of salable products prepared from these plants is so small that their commercial cultivation would be impracticable, since their production in any considerable quantity would result in overstocking the market. A few medicinal plants, such as peppermint, spearmint, wormwood, wormseed, and tansy, are now grown commercially, chiefly as a source of volatile oils, but the relatively small acreage devoted to these crops is restricted to certain localities which have been found to be especially suitable for their production. Sage is a well-known market-garden product, but there is a small acreage of this crop grown exclusively for the production of the dry-leaf sage, much in demand by sausage makers and spice grinders. (See Pl. I.)

The growing of ginseng and goldenseal is a small but well-established industry in several States, but it is well recognized that each of these crops requires a heavy initial outlay

and that five or more years must elapse after the germination of the seeds before any returns can be expected.

CANNABIS AND PEPPERS IN THE SOUTH.

Cannabis is now grown commercially as a side line by a few farmers in South Carolina and by occasional individuals in some other States. Two large drug manufacturers also grow sufficient cannabis for their own needs. Considerable technical skill is required to produce cannabis of a quality that will meet the standard requirements for this drug. Cannabis grown in some localities is deficient in the active principles upon which its value depends, and preliminary tests to determine the quality of the product are therefore always advisable before planting this crop on a commercial scale.

The commercial production of peppers for the drug and spice markets receives some attention in South Carolina, Louisiana, and some of the States of the Southwest. A market has been found for the small species used by pharmacists and for the larger species employed in manufacturing the ground red pepper, such as paprika, which is extensively used as a condiment. In Florence County, S. C., a pepper growers' association has been formed among the farmers growing this crop. The chief objects of this organization are to maintain a pure seed supply and to facilitate the marketing of the product. Through the cooperation thus secured it has been possible to overcome many of the marketing difficulties which were encountered when the crop from this locality was first introduced to the trade.

EXPERIMENTS WITH CAMPHOR.

The experiments with the camphor tree begun in Florida about 12 years ago by the Bureau of Plant Industry have led to the recent planting of this tree on an extensive scale for the commercial production of camphor gum. This tree has long been grown as an ornamental in various parts of the South, and in several localities in Florida there are small plantings, now well grown, which were made with a view to the production of camphor gum in marketable quantities. The experience thus far gained indicates that the cost of producing camphor gum from small plantings is prohibitive,

owing to the necessarily heavy overhead charges, and particularly the outlay required for the indispensable distilling plant. The smallest practicable commercial planting has been estimated at 500 acres, while it is believed that a plantation must cover several thousand acres in order to afford the best opportunity for reducing the cost of production to the minimum.

DIGITALIS.

Digitalis is one of the important drugs the normal supply of which has been seriously curtailed by the war in Europe. Attracted by the high market prices of these drugs, which include belladonna and henbane, many persons have recently attempted to cultivate them as a source of profit. The number of failures, however, has been relatively very large, either on account of inexperience or because of inability to provide the soil, climatic, and cultural conditions necessary for the successful growth of these plants.

Although very little digitalis is now cultivated as a drug crop, no serious market shortage need necessarily occur, since this plant, escaped from cultivation, grows wild over extensive areas in western Oregon and Washington, where, with proper encouragement, a supply sufficient to meet all domestic needs could be readily collected. For this reason it is doubtful whether present conditions warrant the growing of digitalis on land which might otherwise be devoted to the production of food crops.

BELLADONNA.

The continued high price of belladonna since the beginning of the present war has greatly stimulated interest in the production of this crop, but the acreage planted has been greatly restricted on account of inability to secure reliable seed at reasonable prices and because of the high cost of labor and the outlay required to provide the greenhouse facilities desirable for the successful propagation of thrifty plants. Information obtained from the best sources available indicates that approximately 100 acres of belladonna were harvested in this country in 1917. Although it is desirable that the acreage should be increased sufficiently to provide an adequate supply of this drug, it must be borne

FIG. 1.—FIELD OF BELLADONNA.

FIG. 2.—FIELD OF SAGE.

DRUG CROPS UNDER CULTIVATION ON A COMMERCIAL SCALE IN WISCONSIN.

FIG. 1.—BELLADONNA SEEDLINGS IN A GREENHOUSE READY FOR TRANSPLANTING.

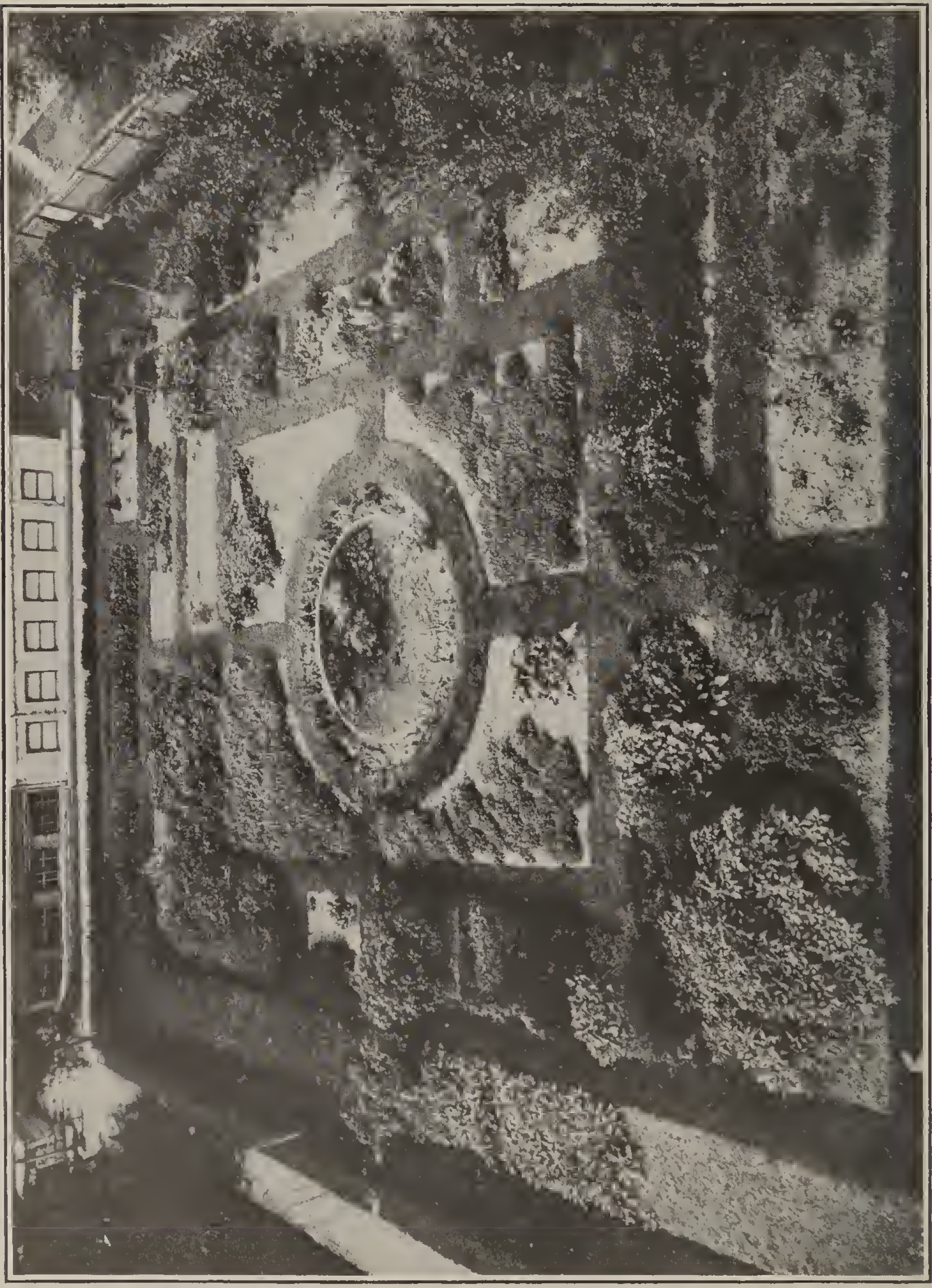
Belladonna is grown most readily from seeds sown in flats in the greenhouse in midwinter and transplanted to small pots in which they are handled like tomato plants, so that they may be ready for transplanting in the field as soon as danger of frost is over in the spring. Sowing belladonna seeds in the field or transplanting directly from the seed bed to the field has rarely given good results in this country.

FIG. 2.—DRUG GARDEN OF NATIVE WOODLAND HERBS.

Portion of garden on the grounds of a university. Here the conditions under which woodland herbs grow naturally have been duplicated as closely as possible.

WILD GROWTH OF FOXGLOVE (DIGITALIS PURPUREA) ALONG A RAILWAY IN OREGON.

This plant is not grown extensively for drug production in the United States, but it has been widely introduced as an ornamental, and in many localities in Oregon and Washington, where it has escaped from cultivation, it is now found growing as a weed in such abundance that supplies sufficient to replace the shortage due to cessation of imports could readily be collected.



DRUG GARDEN FOR SCHOOL OF PHARMACY.

Drug gardens are now being maintained as a feature of the courses in pharmacy in a number of universities. This illustration shows a garden in which the cultures of medicinal plants furnish material of educational value for the pharmacy course and also serve as an ornamental addition to the grounds of the university.

in mind that all the belladonna needed can be grown on a very few acres. The quantity of belladonna annually consumed in the United States is not definitely known, but it has been estimated by men in the drug trade at approximately 300,000 pounds. Since the average yield per acre of dry belladonna leaves is about 600 pounds, it is evident that the area planted to this crop could not much exceed 500 acres without serious danger of overproduction. Indeed, any substantial increase in the present small acreage, by making more certain an available supply, will naturally tend to cause a material reduction in the market price.

HENBANE.

With very few exceptions, recent attempts to cultivate henbane as a drug crop in this country have resulted in failure. Although this plant is occasionally found growing wild in a number of the Northern States, it has not responded readily to cultivation on a field scale. When the seeds are sown in open ground germination is frequently uncertain, and often young plants grown under glass do not survive transplanting in the field. The leaves of henbane usually suffer severely from attacks of the potato beetle, and the crop is very likely to be destroyed if grown within the range of this insect. Since the difficulties connected with the cultivation of henbane are so great, this crop is not a desirable one for persons who can not well afford the loss which would be occasioned by a crop failure.

OTHER DRUG PLANTS.

A number of drug plants not mentioned here[1] are grown in a small way in various localities in this country, chiefly to supply a local demand. However, since the demand for them is very limited or a wild supply fairly available, their cultivation on a more extensive scale does not offer much prospect of profit.

HAPHAZARD PRODUCTION UNDESIRABLE.

As a safeguard to the public health, laws have been enacted which require manufacturers of drugs and medicines to

[1] A detailed discussion of the cultivation of these plants is given in Farmers' Bulletin 663, entitled "Drug Plants under Cultivation," 1915.

maintain certain standards of purity and quality in their products. Official standards of quality have also been adopted for the more important crude drugs in common use. It is quite evident, therefore, that securing a high standard of quality should be a primary consideration in the production of drugs under cultivation. There are, however, good reasons for believing that this end will not be attained through the production of a small quantity of drugs by each of a large number of persons unskilled in drug growing, since the product would be very irregular in appearance and quality, owing to wide variation in the methods used in collecting, curing, preserving, and packing the drugs for market. For the production of a dependable supply of cultivated crude drugs of high quality, reliance must be placed upon well-equipped growers who make the growing of drug plants a special industry and who have the necessary experience in special methods of plant culture, acquaintance with trade requirements, and knowledge of the influence of time of collection and manner of preparation on the constituents of the drug upon which its value depends. If developed along these lines, commercial drug growing in this country promises to become established upon a sound basis for the future, when normal conditions return.

PRIME IMPORTANCE OF MARKET.

The person who seriously considers growing drug plants for profit can scarcely give too much attention to the problem of finding a market for his product. Unless the grower lives near a city in which dealers in crude drugs are located, the disposal of a small crop will present many difficulties. If the crop is shipped to a distant dealer the deductions which will probably be made on account of transportation charges and defective quality may so reduce the returns that the transaction will show little, if any, profit. The grower who produces a quantity of crude drugs sufficient to justify the expense of having their quality determined by a reliable analyst, and who is well informed in respect to the condition of the wholesale market, will be in a position to judge the fairness of the prices offered for his crop by the dealers and to protect his interests in effecting a sale.

Since this country has entered into war, many persons have seriously considered growing drug plants, not for profit but for patriotic reasons. This commendable spirit has been especially evident in many of the women's organizations throughout the country. However, it is not regarded as advisable to encourage this form of activity, since the need for women's services is so much greater in the work of food production and conservation and in preparing the various articles so much needed for the aid and comfort of the men at the front. Moreover, unless closely supervised by some central authority, any extensive movement to grow drugs might easily result in the production of far larger quantities than are needed. This would involve a useless expenditure of effort, which might accomplish much good if exerted in other ways.

DRUG GARDENS FOR SCHOOLS OF PHARMACY.

An important feature of the development of drug-plant culture in the United States has been the establishment of medicinal-plant gardens as an adjunct of the schools of pharmacy of a number of colleges and universities. Unfortunately, the purpose for which these gardens were established is frequently misunderstood. They were designed primarily not as sources of information regarding the commercial cultivation of drug plants, but to facilitate and enrich the courses of instruction in the characteristics and properties of medicinal plants. During the last three or four years these educational gardens have rapidly increased in number and now form a part of the regular teaching equipment of 18 different institutions.

Although these gardens are not devoted to commercial drug growing, nevertheless they can be made to contribute in a very practical way to the public welfare. They afford unusual opportunities for students of pharmacy to acquire a thorough knowledge of many medicinal plants and to be thereby better enabled to recognize inferiority or adulteration in crude drugs. These gardens also supply material useful in the investigation of many problems arising in the necessary revision of the United States Pharmacopœia and the National Formulary, the official standards for drugs

under the national food and drugs act. Since the improvement of the quality of drugs and the perfecting of the standards by which a high quality of drugs and medicines may be maintained are both questions of national concern, the service which the institutional drug garden can render in attaining these ends is worthy of wider recognition.

Much pioneer work remains to be done in establishing correct methods for the cultivation of drug plants and in determining the localities where the conditions are most favorable for the production of each particular drug. The progress of this work will be greatly furthered by the educational drug gardens, since they are located in widely separated localities and offer unusual opportunities for obtaining data on the behavior of drug plants under very diverse conditions of soil and climate. The obtaining of such data is the necessary preliminary step toward any rational experiments in commercial drug growing.

O

PRODUCTION OF VOLATILE OILS IN THE UNITED STATES*

By Dr. W. W. Stockberger, Physiologist in Charge of Drug Plant and Poisonous Plant Investigation, Bureau of Plant Industry, Washington, D. C.

The subject upon which I have been invited to address you is one of perennial interest. Many phases have been very ably presented at previous meetings of the Manufacturing Perfumers' Association, the members of which are ever on the alert to acquire additional information regarding the sources and production of the materials included in the perfumers' armamentary. I have assumed that your request for me to speak to you indicated a

GINGER LILY—A POSSIBLE NEW PERFUME PLANT.

desire on your part to learn at first hand something of the work of the Bureau of Plant Industry, of the U. S. Department of Agriculture, on the production of volatile oils in this country. Accordingly, I shall confine my remarks almost entirely to the experimental work which I am directing, and with the aid of a few lantern slides, I shall try to show you something of the progress we are making and also to indicate some of the obstacles we have encountered.

In the Drug and Oil-Plant Garden at Arlington Farm, Va., many odoriferous plants are grown and distilled. For each species the cultural requirements and adaptation to soil and climatic conditions are studied and the yield of volatile oil and its constituents determined. If the indications are satisfactory up to this point, then comes the task of finding a location where the economic conditions are favorable for the establishment of an industry in volatile oil production. One of the most interesting features of the work at Arlington Farm is the Perfume-Rose Garden, where from time to time a total of 95 varieties of roses have been tested. All but 41 varieties have now been discarded as unsuitable, and of those remaining a number of varieties of *Rosa rugosa* and *Rosa centifolia* have been found the most promising. During the coming summer it is planned to make some practical tests with perfume roses in one or two favorable localities in the Southern States.

At Arlington Farm there are also grown Lavender, Caraway, Anise, Wormwood, several species of the Mint Family, Rosemary, and other species which yield important essential oils. Duplicate tests are made at testing gardens in various parts of the United States. A number of colleges and universities maintain Medicinal Plant Gardens and co-operate informally with the Bureau of Plant Industry in obtaining data regarding the production and utilization of oil-bearing plants.

At Madison, Wis., extensive experiments with Drug and Oil-Bearing Plants are being carried on under formal co-operation between the University of Wisconsin and the Bureau of Plant Industry. One phase of the research on oil plants in progress at the Madison Garden may be illustrated by reference to the work of Mr. G. A. Russell, of the Bureau of Plant Industry, on *Acorus calamus*, the source of calamus oil.[1] This plant usually occurs in low, swampy situations, but we have found that it thrives on well-drained upland soil. Mr. Russell has studied the oil from the roots, rhizomes and leaves of Calamus, grown on upland soil at Madison. The oils from different parts of the plant were found to differ markedly in their properties, due apparently to the relative quantities of terpenes or sesquiterpenes present in these oils.

Another series of studies is in progress on wild oil bearing plants which occur in great abundance in certain localities in the United States. The character of this work may be illustrated by reference to the steam distilled oil of *Artemisia frigida*, wild sage, or mountain sage, which was first studied by Frank Rabak, of the Bureau of Plant Industry, who determined Cineol,

EXPERIMENTAL FIELD STILL.

Fenchone and Borneol as the chief constituents of this oil.[2] A related plant, *Ramona stachyoides* (black sage) from Southern California, has also been studied by Rabak and others. The principal constituents of the oil of this plant are Pinene, Cineol, Dipentine, Thujone and Camphor. The investigation of these plants has led to the examination of the oils of other species, that from *Artemisia tridentata* having recently attracted widespread attention as a new flotative agent for separating various ores.

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*Read before the Manufacturing Perfumers' Association

[1] Journ. Amer. Chem. Society, Vol. 37, No. 10. October, 1915.

[2] Bureau of Plant Industry Bulletin No. 235, 1912.

At Orlando, Florida, we have a large and fairly well equipped laboratory for the experimental study of volatile oil production in all its phases. A small experimental farm of 40 acres is also available on which various crops of oil-bearing plants are grown on a field scale. The data secured from the practical field tests and in the laboratory form the basis of our estimates of the possibilities for the commercial production of the volatile oil plants, under observation. One feature of the work at the Orlando Laboratory during the past year was the invention of a machine for peeling waste and cull oranges and the devising of a simple and practical method of extracting the oil from the orange peel. A description of the machine and the details of the process of extracting orange oil have been published in Department of Agriculture Bulletin No. 399, and need no further comment here.

TRIAL PLANTING OF ROSE GERANIUM IN FLORIDA.

A brief reference to a few of the species of oil-bearing plants under study at Orlando, will now serve to illustrate the character of the work in progress there. From *Monarda punctata* we obtain oil of horsemint, which contains a high percentage of thymol. Our experiments with this plant under cultivation for a period of over 6 years justify the conclusion that yields of from 30 to 40 pounds of oil per acre may be expected. Assuming a market price of $2 per pound, we estimate that the commercial production of this oil can be made to show a profit of about $16 per acre.[3]

The plant *Cymbopogon citratus* yields the Lemongrass Oil now extensively used for the manufacture of Citral, from which Ionone and similar products are obtained. The details of the cultivation of this plant in Florida have been worked out, and its commercial possibilities well determined.[4] Tests on acre plots have been made to determine the cost of production, the best method of distilling the oil, and the quality of the product. Small lots of this oil have been sold in our domestic markets at the prices prevailing for the best grade of imported oil, and it seems possible to produce this oil commercially at a fair profit.

Cinnamomum zeylanicum of the family Lauraceae, illustrates how different portions of a plant may yield oils of very different character. In the root oil of this plant, camphor is the chief constituent, in the leaf oil, eugenol, and in the bark oil cinnamic aldehyde. A number of trees of this species have been grown on the experimental grounds at Orlando, Florida, but the danger of occasional low temperatures renders the commercial cultivation of this plant uncertain in areas subject to heavy frosts.

Cinnamomum cassia, the source of cassia oil, which is official in the United States Pharmacopoeia, is also under experimental cultivation at our Florida Station, but the commercial possibilities of this and the preceding species are yet to be determined.

Pycnanthemum albescens is a plant of the family Labiatae, native in the Southern United States. The plant grows well in moist sandy soil and yields from 0.4 to 0.8 per cent of a colorless volatile oil having a characteristic pennyroyal odor. The possible yield per acre of this oil is estimated at 30 to 40 lbs.

The tree known as *Illicium anisatum* of the family Magnoliaceae, is the source of Star Anise Oil. Preliminary tests indicate that this plant is quite hardy in Central Florida and could probably be grown there successfully. Two other species of *Illicium* are native to Florida and may prove of value, but much further investigation will be necessary in order to determine their commercial possibilities.

Eugenia caropohyllata, the clove tree, has made fair growth at our Southern Station, but no commercial prospects for this plant are evident at present.

Persea pubescens, the swamp bay of the South, is another native aromatic plant which has been studied by the Bureau of Plant Industry. The oil contains camphor, cineol and borneol, and may prove to be of interest to perfumers.

Hedychium coronarium, or ginger lily, which belongs to the family Scitaminaceae, may have some value as a perfume plant since the flowers which are very fragrant suggest the gardenia and tuberose.

A FIELD OF LEMON GRASS IN FLORIDA.

Camphor production is another feature of the Florida work. The experiments with this crop have included the propagation and culture of camphor, and laboratory and factory phases of camphor production. It has been shown that the crop is one which requires operations on a large plantation scale, for economic production, and as

(*Continued on page* 24.)

[3] See U. S. Department of Agriculture Bulletin No. 372, 1916.
[4] See U. S. Department of Agriculture Bulletin No. 442, 1917.

THE MARKET.

(Continued from page 22.)

goods are expected to appear on the market has had the usual bearish influence.

Thus far there has been no trading in bulk lots in the primary market with the result that there is no stability of quotations on Mexican beans. However, as ordinary beans are usually the ones which arrive in this market first of all there has been considerable trading on a to arrive basis and the general trend of the market has been downward as competitive selling has brought out sales of ordinary quality on a to arrive basis of as low as $4.00@4.25 for whole beans. These quotations are hardly a fair criterion, however, as the majority of sellers have maintained their views within the range of $4.75@6.00 a pound for whole beans, and $3.50@4.00 for the cuts.

As previously pointed out, no New York operators have as yet come into the market in Mexico to any extent principally because of the lateness of the crop. Reports from crop sections in Mexico indicate that the Indian who would in ordinary years have gathered the vanilla beans say by November or December has not yet brought in any appreciable quantities of the crop.

The action of the Teutonic forces in forcing their passage down to Black Sea ports has forced a materially firmer feeling in the market for Bourbon vanilla beans so much so that there has been an advance of two francs in the Marseilles market. This has forced the quotation in this market to about $2.05@2.07 a pound cost and dock New York, so that good sound free goods have been selling here on a basis of $2.10 a pound with occasional price shading from some houses down to $1.95@2.00. Were it not for the weakness which has been shown in Mexican beans, it is thought that the Bourbon would by this time be quoted on a materially firmer basis. As it is, it has been made clear that Bourbon beans cannot be brought over successfully from France and such arrivals as have taken place and are scheduled to arrive are being held at firm prices.

The market on Tahiti beans has had somewhat of a reaction. Reports from the Pacific Coast indicate that offers have been made down to a basis of $1.00 a pound so that offers locally have been made down to $1.00@1.35 a pound. Latest advices from vanilla bean centres in South America, report that the crop is expected to be large and will undoubtedly come on the market at lower prices.

DEVELOPMENT OF ORANGE OIL INDUSTRY IN JAMAICA.

(Continued from page 11.)

EFFORTS TO MAINTAIN QUALITY.

It is reported that there is a general impression in Jamaica that if the industry of putting up orange oil gets into many hands and the shipping and marketing are independently handled without co-operation the trade will suffer. It is said to be considered quite necessary that the oil sent abroad should be kept up to as high and uniform a standard as possible, for if inferior grades are shipped on the chance of finding a market the result will be not only a probable loss to the individual shipper but an indirect loss to all shippers. It is not an article the consumption of which can be greatly stimulated by cheapness, and from the viewpoint of the producers it would probably be more advantageous to market a limited quantity at good prices than a large quantity at low prices. The latter would probably lead to price cutting, careless production, and the shipping of a poor product to foreign markets.

By far the greater amount of orange oil produced in Jamaica is of the sweet variety. Bitter orange oil is produced in exactly the same way as the sweet oil, except that the bitter oil is obtained from the Seville or sour orange, and is not as valuable as the sweet oil. When the latter is being sold at $1.75 a pound, the producer of bitter oil counts himself fortunate if he succeeds in obtaining $1.25. The bitter oil is used also to flavor cakes and biscuits and, to a lesser degree, in the preparation of perfumes and essences.

PRODUCTION OF VOLATILE OILS.

(Continued from page 9.)

the outcome of the department's work on camphor, several large commercial enterprises have been undertaken.

Among the many species of plants which are now being studied in our several experimental gardens are those yielding the following oils:

Anise	Fennel	Peppermint
Basil	Galangal	Rose
Cajeput	Geranium	Rosemary
Calamus	Ginger	Sage
Camphor	Horsemint	Spearmint
Caraway	Lavender	Tansy
Cassia	Lemongrass	Thyme
Chamomile	Marjoram	Vetiver
Citronella	Orange	Wormseed
Cumin	Palmarosa	Wormwood
Curcuma	Pennyroyal	Ylang Ylang
Eucalyptus		

In so far as time and means permit, the cultural requirements of promising perfumery plants will be worked out and their commercial possibilities in the United States determined. I trust that the results will not be without interest to the members of the Manufacturing Perfumers' Association.

FOREIGN CORRESPONDENCE.

(Continued from page 22.)

be the Compagnie des Produits Aromatiques, Chémiques, et Medicinaux. M. G. Chiris remains as president of the company.

GREAT BRITAIN.

Embargo Prohibitions.—Ambergris and tooth-brushes have been added to the British embargo list.

GREECE.

Olive Crop Small in 1917.—Vice Consul C. M. Corafa, Athens, reports that the Greek olive crop and olive-oil yield has been seriously under the average. As a striking confirmation of this shortage may be noted the recent action of the Ministry of Revictualling and Supplies, which has raised the minimum price of olive oil from $1.76 per gallon to $2.08 per gallon. The price fixed from October of $1.09 per gallon for olives has been increased to $1.32 per gallon. While it is possible that there is some hoarding of olive oil and olives in the provinces, according to the most optmistic estimate the olive-oil crop is perhaps 15 per cent. short, and the olive crop 10 per cent. below the normal production.

ITALY.

Olive Oil.—Naples advices, dated February 4, say: "According to information received by the Societa Nazionale degli Olivicoltori (National Society of Olive Growers), the olive crop in Apulia, the most important region of olive growing, gave an exceedingly disappointing result, the yield being estimated at only about one-fifth of the abundant production of 1916."

PORTUGAL.

Export Prohibition.—A decree of January 24 forbids the export of resins of all kinds.

Some Plain Facts About Drug Cultivation

The Annual Requirements of Digitalis for a Million Persons Could Be Raised on Four or Five Acres of Good Land, and 500 Acres Would Furnish Enough Belladonna to Supply the Nation's Needs—Some Words with the Small Grower.

By DR. W. W. STOCKBERGER.

Much of the enthusiasm now being displayed for medicinal plant cultivation in the United States sorely needs the curb of common sense and ordinary business judgment. The alluring "stories" about the ease and profit of drug growing which all too frequently appear in newspapers and magazines are excellent examples of the art of camouflage, since they successfully divert attention from the very essentials which should be most carefully regarded. The writer of one of these stories, when taken to task for his misleading statements, dismissed the matter with the comment that he cared only to arouse people's interest, and that they might find out the facts for themselves. Unfortunately, the facts are not always investigated, in which case disillusionment and financial loss are the frequent results.

Three important essentials regarding which every prospective grower of drugs should be informed are the cost of production, disposal of the product and the extent of the market requirement.

> *STATUS OF THE SMALL GROWER.*
>
> *"If medicinal plant cultivation is to succeed in this country it must be placed on a sound commercial basis and there are good reasons for believing that this end will not be attained by encouraging a large number of persons to engage in drug growing on a small scale. . . .*
>
> *"If the drug manufacturer is to become permanently interested in medicinal plants produced in this country he must be assured of a fairly large and dependable source of supply. For this, reliance must be placed upon well equipped growers. . . who have sufficient capital to carry on the enterprise effectively."—Dr. W. W. Stockberger.*

Cost of Production.

The amount and cost of the labor necessary for producing a drug crop, such as belladonna, for example, on a large scale, will vary according to circumstances and locality. Assuming that the land, greenhouse facilities for starting the young plants, and a suitable drying house for the crop are all available, there are still a number of important items which require a cash outlay. Some of these are, labor and fuel for greenhouse; plowing, harrowing, and fitting the land; fertilizers; transplanting; replanting; cultivating; hoeing; spraying; harvesting; hauling and drying leaves; digging, washing, hauling and drying roots; fuel and labor for drying houses; baling the dry product; and cartons, burlap or boxes for packing. Under present conditions the question of labor and fuel is a serious one in most localities and must be carefully considered in making estimates of the outlay necessary to cover the items above mentioned.

An additional cash outlay will be necessary if a greenhouse has to be built or hired and a drying house constructed. For leaf drugs like belladonna some means of drying with artificial heat is a necessity if the crop is produced on a commercial scale and unless the drying begins immediately after the leaves are gathered and proceeds rapidly, they are apt to turn brown, and the resulting drug can not be sold readily, since the trade prefers a leaf which retains its natural green color. The capacity of the drying house is a limiting factor of the acreage which can be handled advantageously. A dryer which will handle the crop from four or five acres can be built for a moderate figure, but the cost of a fully equipped modern dryer suitable for handling twenty-five acres or more may easily total several thousand dollars. The permanent investment in equipment of this kind is an expense which the amateur must consider and which should be figured in as an item of cost when the total cost of production is sought.

Disposal of the Product.

The producer of crude drugs, such, for example, as belladonna, henbane, or digitalis, will find that unless his product meets certain exacting trade requirements, he will not be able to dispose of it advantageously, if at all. The appearance of these drugs is always an important factor in their salability. They must be bright, clean, thoroughly dry, with no trace of mould, and well packed to prevent damage while in course of shipment. In so far as possible, leaf drugs should retain their natural green color and, to secure this result, requires the exercise of a degree of skill and judgment in drying the materials that can be attained only through long experience.

Many crude drugs are now bought and sold on a basis of value determined by their content of active principles, as shown by chemical assay or by their potency as indicated by suitable tests of their physiological activity. Drugs like belladonna and digitalis

vary greatly in strength, and the grower who attempts to market his product without first submitting samples to a competent analyst will act unwisely, since he will not know whether he is offering to the trade an inferior drug or one which is of high quality. Armed with an analysis of his product, he will be better enabled to judge the fairness of the offers which he receives and to insist on receiving full value for his crop.

The complaint is often made by drug growers that the prices offered them for their product by drug dealers are much lower than the market quotations, but it should be remembered that the quotations in the trade journals represent prices between dealers or between dealers and jobbers, and are necessarily higher than the producer can expect to receive. In this respect, a drug crop is not different from any other farm crop. No farmer either expects or receives for his crops the prices quoted in the wholesale markets of our cities, and the drug grower also must be prepared to make a reasonable allowance for the expenses and profit of the drug dealer. The prices mentioned in the sensational stories about the large profits to be made by growing drugs are nearly always the highest wholesale quotations, and many persons have been thereby misled in regard to the prices which the drug grower may expect to receive.

Unless the drug grower is fortunate enough to be situated near one of the cities where there are dealers in crude drugs, he is certain to experience some of the difficulties and annoyances always connected with marketing at a distance. Only a large crop would justify the expense of a trip to a distant market for the purpose of personally effecting a sale, and the small grower must depend upon finding a buyer by sending out samples to a number of dealers. After the price, based upon sample, has been agreed upon and the crop shipped to the dealer, the grower must run the risk of rejection or reduction in price if the bulk of the crop does not come up to the sample in quality. It should be apparent to every one that to dispose of drug crops successfully the grower must have some acquaintance with the drug trade and its peculiar demands, and be familiar with modern methods of marketing special products.

THE AUTHOR.

Referring to the latest edition of "Who's Who in America," we learn, among other things, that Dr. Warner W. Stockberger, botanist, was born in Licking County, Ohio, July 10, 1872; that he was a teacher in the public schools of that State from 1895 to 1897; that he was graduated from the Ohio State University in 1901, with a bachelor of science degree, and from Denison University the following year, with the degree of doctor of philosophy. He then spent a year as instructor in botany, and the volume mentioned above briefly summarizes his activities since that time as follows: "Expert in histology, 1903-08; pharmacognosist, 1908-10; plant physiologist, 1910-13; plant physiologist in charge of drug and poisonous plant investigations, United States Department of Agriculture."

Dr. W. W. Stockberger.

Dr. Stockberger is an active member of the American Pharmaceutical Association, and is at present chairman of the scientific section, a member of the council, chairman of the committee on drug plant growing, and of the committee on historical exhibits in the United States Museum, and is president of the Washington branch of the parent body. He is a fellow of the American Association for the Advancement of Science, and is a member of the Botanical Society of America, the American Breeders' Association, and other scientific bodies. Among his best known papers, which have appeared in the reports of the Department of Agriculture and various scientific publications, may be mentioned "The Drug Known as Pinkroot," "Tannin Plants of Paraguay," "Medicinal Plant Gardens," "Drug Plants Under Cultivation," "Drug Plant Culture in 1916," and "Drug Plant Breeding."

It is apparent that whatever Dr. Stockberger may have to say concerning drug plant cultivation will be based on wide experience and a knowledge born of many years of work along botanical lines, and should, therefore, be of particular interest to those who are contemplating the establishment of a drug plant garden.

Extent of Market Requirements.

Without some knowledge of the quantity of various crude drugs necessary to meet the annual requirements of the drug trade, very erroneous ideas are apt to be acquired regarding the opportunity for profitable drug growing in this country. Many persons have evidently given this important matter no consideration, or have assumed that the demand for crude drugs is as great as the demand for fruits, vegetables or staple crops. Popular writers who urge drug growing upon a wide circle of readers do so with a fine disregard of actual possibilities. The absurdity of a general appeal to farmers to grow such drugs as digitalis or belladonna, for example, is self-evident. In the United States there are 10,000,000 farms, and if one farmer in every ten should each year produce one pound of digitalis the annual crop would be 1,000,000 pounds, or 500 tons. It has been estimated that one ton of digitalis leaves will be more than sufficient to meet all the needs of 1,000,000 men for this drug for a year, and 500 tons would, therefore, be several times more than the annual requirement for the entire population of the United States, assuming that each person had need for this drug. Since an acre of land may be expected to produce 400 to 500 pounds of digitalis, the annual requirement of 1,000,000 persons could be produced on four or five acres of good land.

The situation with respect to belladonna is no less interesting. It has been estimated by persons in the drug trade that the annual requirement of belladonna in the United States is approximately 300,000 pounds. Since the average yield per acre of dry belladonna leaves is about 600 pounds, it is probable that the demands of the drug trade could be fully satisfied by the quantity of belladonna which could be produced on approximately 500 acres of good

land. Over two acres of belladonna were harvested in the United States in 1917, and judging from present indications several hundred acres will be planted in the spring of 1918. While it is very desirable to have planted an acreage of belladonna sufficient to supply all requirements, the extensive planting of belladonna by a large number of persons is certainly inadvisable, since it would probably result in the overproduction of the crop.

What has just been said about digitalis and belladonna applies in a general way to most drug crops, which have been popularly recommended for cultivation in this country. Important and valuable as these drugs are, the fact should not be lost sight of that the ponderable quantity of drug products annually consumed by an individual is exceedingly small in comparison with the quantity of food products required in the same time. As an agricultural enterprise, therefore, drug growing, in contrast with the production of food crops, affords an opportunity for a very limited number of persons to engage in it with any prospect of success.

Drug Growing in Greenhouses.

The growing of drugs in greenhouses is regarded as impracticable, since the cost of production would probably far exceed the returns from a crop grown under that condition. In some of the Eastern States considerable publicity has recently been given to a plan to promote the commercial cultivation of medicinal plants in the way mentioned, but in view of the fact that there are many localities in the United States where crops of these plants can be grown much more cheaply and with greater certainty as field crops, the use of greenhouses for this purpose seems inadvisable. The greenhouse has its place in drug growing, but merely as a means of starting young plants, which are to be transplanted to the open field in the spring as soon as the danger of frost is past. Under present conditions, the conservation of labor and material resources demands first consideration, and every precaution should be taken to avoid the useless expenditure of effort which might accomplish much good if exerted in other ways.

Drug Growing Must Have a Sound Basis.

If medicinal plant cultivation is to succeed in this country it must be placed on a sound commercial basis. There are good reasons for believing that this end will not be attained by encouraging a large [illegible] drug growing on a small scale [illegible] who are now anxious to grow [illegible] the present [illegible] would be equally anxious to plan[illegible] Moreover, with a large number of small growers, production [illegible] demands and the result would be overproduction in some [illegible] in others.

If the drug manufacturer [illegible] interested in medicinal plants produced under cultivation in this country he must be assured of a fairly large and dependable source of supply. For this, he must depend upon well equipped growers, who make the cultivation of drug plants a special business and who have sufficient capital to carry on the enterprise effectively. On the other hand, if the drug grower is to be successful, he must have the cooperation and active support of the drug manufacturer, who should realize that fostering domestic drug growing will provide a safeguard for a number of indispensable products against a future repetition of the market conditions which have prevailed since the beginning of the war. If developed along these lines, commercial drug growing in this country promises to become established upon a sound basis for the future when normal conditions return.

No Rights Under Lottery Contract.

A pharmacist made a contract with a company under which the latter agreed to promote his sales by means of a voting contest during which an automobile and other prizes were to be distributed. The plan constituted a lottery and was therefore illegal. The company gave bond to secure performance of its part of the contract, under which it undertook to increase the druggist's sales $20,000 within twelve months. Held, that the contract was not only void as between the parties, but that it so tainted the bond with illegality as to release the surety from any liability thereon. (North Carolina Supreme Court, Basnight vs. American Manufacturing Co., 39 Southeastern Reporter, 734.)

All your Greek will never advance you from secretary to envoy, or from envoy to ambassador; but your address, your air, your manner, if good, may.—*Chesterfield.*

What is Wrong With Our Method of Pharmacopœial Revision?

Or is there anything the matter with it? This question has been submitted to a number of pharmacists, physicians and chemists interested in Pharmacopœial revision and some of the answers received from them will be published in the April issue of the CIRCULAR. Among those who have thus far replied to the question are:

Harvey W. Wiley.	Charles H. LaWall.	Henry Kraemer.
W. L. Scoville.	Virgil Coblentz.	H. V. Arny.
Horatio C. Wood.	G. D. Rosengarten.	L. E. Sayre.
David M. R. Culbreth.	Torald Sollman.	John K. Thum.
A. R. L. Dohme.	Harry B. French, for the Philadelphia Drug Exchange.	

Revising the Pharmacopœia is an increasingly important and difficult task and the suggestions of these members of the Ninth Revision Committee should be helpful to the committee which will later work on the Tenth Revision.

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H. K. Mulford Biological Laboratories,
Glenolden, Pa.

THE STATUS OF DRUG PLANT GROWING IN THE UNITED STATES IN 1921.*

BY W. W. STOCKBERGER.[1]

The commercial production of drug plants under cultivation did not escape the general depression occasioned in almost every phase of agricultural activity by the sharp decline in prices which closely followed the ending of the World War. As was not unexpected the renewal of imported supplies brought about a competition that could not be met by domestic growers, many of whom discontinued entirely the cultivation of certain medicinals with which they had had considerable success during the war years.

With the year 1921 the effects of the artificial stimulus imparted to drug growing by the World War practically disappeared, leaving the general situation much the same as it was in pre-war years. Although this result might be taken as an indication that there is no further opportunity for drug growing in this country, there are on the contrary good reasons for regarding this apparently unfavorable outcome as actual progress toward the establishment of this industry on a sound economic basis. The situation in 1921 fully sustains the judgment of those who maintained a conservative attitude toward drug growing under war conditions and who realized that no permanency could be assured this industry except through its rational adjustment to approximately normal conditions of crop production and consumptive demand.

The experience of the past five years has greatly extended our knowledge in respect to localities in this country suitable for growing certain drug plants and concerning the labor and risks involved in the care and harvesting of drug crops. This experience has largely dispelled the illusions maintained for some years by a group of over-enthusiasts respecting the possibilities of deriving great monetary returns from drug growing and has brought about a general recognition of the fact that the demand for most of these crops is relatively small and that the suc-

* Read before Scientific Section, A. Ph. A., Cleveland meeting, 1922.

[1] Physiologist in charge of Drug, Poisonous and Oil Plant Investigations, Bureau of Plant Industry, U. S. Department of Agriculture.

cessful marketing of drug crops is a more difficult and important problem than that of their production. It must be remembered that during what may be called the war period of drug cultivation popular interest was largely centered upon only a few of the drug plants for which there exist suitable locations among the varied conditions of soil and climate afforded by this country. The keenest demand in the emergency was for certain drugs that had been previously obtainable from abroad at prices so low that their cultivation in this country was not profitable, consequently the efforts of growers were largely directed to the production of such drugs as belladonna, henbane and stramonium to the exclusion of others for which the demand was less urgent.

From such data as it has been possible to obtain it appears that in 1921, in addition to the areas devoted to ginseng, hydrastis, cannabis, and insect flowers, were grown in this country two to three acres each of belladonna and digitalis, about ten of sage, and an indefinite number of small plantings of pinkroot, blood root, lovage, horehound, podophyllum, aletris, senega, cypripedium and other drug plants.

A large part of the ginseng produced under cultivation is grown in Wisconsin, Minnesota, Michigan, Iowa and Ohio, but there are extensive plantings of this crop in New York, Pennsylvania, Georgia, Kentucky, Tennessee, Washington and a number of other states. The gardens range in size from a few square rods to fourteen acres or more. There is no definite information respecting the annual production of cultivated ginseng. The exportation of both wild and cultivated root amount to 157,351 pounds in 1921 and it has been estimated that about 60 per cent. of this quantity came from gardens under cultivation. The value of the cultivated crop as calculated from the average export valuation was $974,097, but the net return to the growers was of course considerably less.

The acreage devoted to the production of hydrastis has been gradually increasing for several years but the slump in the market in 1921 greatly restricted new plantings. Many ginseng growers whose crop had been largely or entirely destroyed by diseases replanted their gardens with hydrastis and many new plantings also were made in various parts of the country where climatic and soil conditions were not so favorable for ginseng. This expansion of acreage and consequent increase in production coupled with the lack of foreign demand resulted in a market situation in 1921 which was very disappointing to the growers. Unfortunately there are no available figures showing the acreage and production of hydrastis. It may be noted, however, that at the end of the year more of this drug was being offered than the market would absorb.

A decline in the cultivation of cannabis was evident in 1921 although small areas were grown in South Carolina, Virginia and Illinois, totaling approximately 25 acres. On account of the low prices obtainable for domestic cannabis several growers have stated their intention to discontinue the growing of this drug.

The production of sage except as a home and market garden crop nearly reached the vanishing point in 1921. Growers have found it practically impossible to produce sage which will fall within the standard limits for total and insoluble ash; consequently their product has been rejected on the market. Some have tried to overcome this difficulty by washing the sage as soon as it was harvested but this adds to the cost of production, interferes seriously with the process of drying,

and endangers the quality of the finished product. With satisfactory offers for their crop in hand some growers have left fields of fine sage unharvested on account of the anticipated difficulty in marketing.

In comparison with the quantity of insect flowers imported from Japan domestic production of these flowers in 1921 was entirely negligible. Small quantities produced experimentally in South Carolina and Wisconsin have been found the equal of Japanese flowers in effectiveness of action on certain insects. Upon analysis, however, the content of insoluble ash of these domestic flowers was found to run considerably above the standard limit of 2 per cent.; consequently dealers refused to purchase them. Should this high content of insoluble ash prove to be a constant characteristic of insect flowers grown in the eastern part of the United States it is unlikely that much interest will develop in their commercial cultivation.

Notwithstanding the unfavorable outlook for commercial drug growing occasioned in 1921 by the disparity between production costs and market returns, stocks of propagating material were maintained by many growers for the purpose of again extending their plantings as soon as conditions become favorable.

No statement regarding drug-plant growing in this country should omit some reference at least to the drug gardens maintained in connection with various schools of pharmacy. In 1921 the growing of drug plants was a feature of the educational work at twenty-six different institutions and at several others plans were being made to establish drug gardens as soon as facilities were available.

Insufficient funds and changes in personnel have restricted the work of some gardens but others have been more fortunate. One of these gardens has won the appreciation and support of the Pharmaceutical Association in the state where it is located and through a section devoted to poisonous plants has developed among the graduate veterinarians in the state a broader interest in the relation of these plants to animal health; at another garden plans are well developed for an important biochemical study of the mints which will involve research in the fields of both genetics and plant chemistry; still another garden has been materially extended through the generosity of a prominent manufacturer of pharmaceuticals who appreciates the increased opportunity which the garden affords for research work on drug plants.

The development of special fields of activity by different gardens is a gratifying sign of progress and clearly indicates the undesirability of a set formula of procedure to be followed by all. The specialization made necessary by the limitations peculiar to each garden will bring about not only an extension of the scope of the work on drug plants but also an increased appreciation of the aim and object of pharmaceutical education.

A REVIEW OF THE LITERATURE IN PHARMACEUTICAL BOTANY AND PHARMACOGNOSY FOR 1921–1922 (AUGUST 1, 1921–AUGUST 1, 1922).*

BY HEBER W. YOUNGKEN.

I am deeply gratified by the large number of excellent papers published during the last year in the field of pharmacognosy and pharmaceutical botany. Scien-

* Scientific Section, A. Ph. A., Cleveland meeting, 1922.

[Reprinted from THE AMERICAN NATURALIST, Vol. XLVI., March, 1912.]

A LITERARY NOTE ON MENDEL'S LAW

THE ever-increasing extension of the doctrine of Mendelism brings it year by year to the attention of a widening circle of general readers. Its application in the field of eugenics has aroused a popular desire for a further knowledge of the now famous principles of Mendel. Owing to the relative inaccessibility of Mendel's original publication the exact terms in which he formulated his conclusions have not been readily available. To meet in some measure this lack of ready reference the following brief, synoptic statement of the fundamental principles of Mendel is here presented in his own words, together with certain collateral notes that may be of value to students of this important law.

The general term "Mendel's Law" is usually applied to several complex principles discovered by Gregor Mendel while studying inheritance in certain plant hybrids. Various other designations, however, appear in the literature, *e. g.*, Mendel's "Law of Heredity,"[1] "Law of Inheritance,"[2] "Laws of Alternative Inheritance,"[3] and "Law of Varietal Hybrids."[4] These principles were enunciated by Mendel in a paper entitled, "*Versuche über Pflanzenhybriden*" ("Researches on Plant Hybrids"), which appeared in the *Verhandlungen der naturforschenden Vereines in Brünn*, Vol. 4, 1865, *Abhandlungen*, pp. 3–47,[5] but escaped the attention of biologists until the year 1900, when by De Vries,[6] Correns[7] and von Tschermak,[8] they

[1] Castle, W. E., *Proceedings American Academy of Arts and Sciences*, Vol. 38, 1903, p. 535.

[2] Biffin, R. H., *Journal Agricultural Science*, Vol. 1, 1905, p. 1.

[3] Weldon, W. F. R., *Biometrika*, Vol. 1, 1901, p. 228.

[4] De Vries, H., "Species and Varieties," Chicago, 1905, p. 716.

[5] Reprinted in *Flora*, Vol. 89, 1901, pp. 364–403.

[6] De Vries, H., "Das Spaltungsgesetz der Bastarde," *Berichte der deutschen botanischen Gesellschaft*, Vol. 18, 1900, pp. 83–90.

[7] Correns, C., "G. Mendels Regel über das Verhalten der Nachkommenschaft der Rassenbastarde," *Berichte der deutschen botanischen Gesellschaft*, Vol. 18, 1900, pp. 158–168.

were independently and almost simultaneously rediscovered.[9]

Mendel's principles have been rephrased by later writers, and they are now usually referred to as the Law of Dominance, the Law of Segregation, and the Law of Recombination, respectively.

I. The Law of Dominance[10]

This so-called law is derived from the following principle of Mendel ("Versuche," etc., pp. 10–11):

> In der weiteren Besprechung werden jene Merkmale, welche ganz oder fast unverändert in die Hybride-Verbindung übergehen, somit selbst die Hybriden-Merkmale repräsentiren, als *dominierende,* und jene, welche in der Verbindung latent werden, als *recessive* bezeichnet.

Translated this principle reads:

> Those characters which pass entirely or almost entirely unchanged into the hybrid combination and consequently in themselves represent the characters of the hybrid, are designated as *dominant,* and those which become latent in the combination are termed *recessive.*

Since dominance is rarely absolute this principle is not general and should not be termed a law; indeed Mendel did not claim it as a law. Recent statements of the "Law of Dominance" may be thus summarized:

> When the two parents differ in respect of two contrasted characters, only one, the dominant character, will appear in the hybrid. Dominance, however, is seldom perfect, so that the dominant character in a hybrid seldom reaches as full expression as in the dominant parent.

II. The Law of Segregation.

Mendel's second principle ("Versuche," etc., p. 17) is thus stated:

[8] Von Tschermak, E., "Ueber künstliche Kreuzung bei *Pisum sativum,*" *Zeitschrift für das landwirtschaftliche Versuchswesen in Oesterreich,* Vol. 3, 1900, pp. 465–555.

[9] De Vries's paper was received for publication on March 14, 1900, and that of Correns on April 24, 1900. Tschermak, in a postscript to his communication, says: "Die gleichzeitige Entdeckung Mendels durch Correns, de Vries (*Berichte der deutschen botanischen Gesellschaft,* 1900) und mich erscheint mir besonders erfreulich."

[10] "Man hat dieses die 'Prävalenz-Regel' genannt," Correns, C., "Uber Vererbungsgesetze," *Verhandlungen der Gesellschaft deutscher Naturforscher und Arzte,* 77 Versammlung, 1905, Part I, Leipzig 1906, p. 207.

Da die Glieder der ersten Generation unmittelbar aus den Samen der Hybriden hervorgehen, wird es nun ersichtlich, dass die Hybriden je zweier differirender Merkmale Samen bilden, von denen die eine Hälfte wieder die Hybridform entwickelt, während die andere Pflanzen gibt, welche constant bleiben, und zu gleichen Theilen den dominirenden und recessiven Character erhalten.

This may be translated as follows:

Since the members of the first generation[11] arise directly from the seeds of the hybrids, it is now evident that hybrids, for each pair of differentiating characters, form seeds, one half of which develops again the hybrid form, while the other half produces plants which remain constant and in equal proportions receive the dominant and recessive characters.

Various terms have been applied to this law by different authors, *e. g.*, "Law of Disjunction,"[12] "Law of Purity of Germ Cells,"[13] "Law of Separation of Characters in Crosses,"[14] and "Law of Dichotomy."[15] Generalized, the law may be stated in the following form:

In self-fertilized species an individual which is a hybrid with reference to a particular pair of characters tends to produce progeny one fourth of which is of pure race like one of the parents of the hybrid, another fourth of pure race like the other parent, while the remaining half is hybrid, like the original hybrid itself,"[16] that is, "from the inbred heterozygote come dominants and recessives in the proportion of 3:1, and only one dominant in three is pure, the other two being heterozygote.[17]

The above statement is purely objective;[18] it states the results

[11] This is the F_2 generation of current literature.

[12] De Vries, H., *Comptes rendus de l'académie des sciences*, Paris, Vol. 130, 1900, pp. 845–847.

[13] Castle, W. E., *Proceedings American Academy of Arts and Sciences*, Vol. 38, 1903, p. 537.

[14] De Vries, H., *Journal Royal Horticultural Society*, Vol. 25, 1901, p. 243.

[15] Davenport, C. B., *Biological Bulletin*, Vol. 2, 1901, p. 307.

[16] Spillman, W. J., "Application of Some of the Principles of Heredity to Plant Breeding," Bulletin No. 165, Bureau of Plant Industry, U. S. Dept. Agriculture, 1909, p. 9.

[17] Punnett, R. C., "Mendelism." Cambridge, 1907, p. 23.

[18] For this paragraph and the one immediately following, the writer is indebted to Professor W. J. Spillman.

of a cause, but gives no hint of that cause. It is not strange, therefore, that the modern statement of this law should have gravitated backward toward the fundamental cause underlying the law. The more usual statement of it at the present time is an inference from the facts observed, and may be stated as follows:

When an individual is heterozygous for a given character it produces two kinds of gametes with reference to that character, one like those of one of its parents and the other like those of the other parent.

Mendel himself gives the corresponding statement of the law of recombination; that is, he states the inference about the kinds of gametes a hybrid must produce, as inferred by the types of the resulting progeny.

The principle of segregation, closely approximated long prior to Mendel both by Goss[19] and by Sageret,[20] was clearly enunciated by Naudin,[21] but these writers did not formulate their

[19] "In the summer of 1820, I deprived some blossoms of the *Prolific blue* of their stamens, and the next day applied the pollen of a *dwarf Pea,* and of which impregnation I obtained three pods of seeds. In the following spring, when these were opened, in order to sow the seed, I found, to my surprise, that the colour of the Peas, instead of being a deep blue, like their female parent was of a *yellowish white,* like the male. Towards the end of the summer I was equally surprised to find that these white seeds had produced some pods with all blue, some with all white, and many with both blue and white Peas in the same pod.

"Last spring, I separated all the blue Peas from the white, and sowed each colour in separate rows; and I now find that the blue produce only blue, while the white seeds yield some pods with all white, and some with both blue and white Peas intermixed."—Goss, John, "On the Variation in the Colour of Peas, occasioned by Cross Impregnation." In a letter to the Secretary. Read October 15, 1822. *Transactions of the Horticultural Society of London,* Vol. 5, 1824, pp. 234–235.

[20] "Ainsi donc, en définitive il m'a paru qu'en général la ressemblance de l'hybride à ses deux ascendans consistait, non dans une fusion intime des divers caractèrs propres à chacun d'eux en particulier, mais bien plutôt dans une distribution, soit égale, soit inégale, de ces mêmes caractères: je dis égale ou inégale, parce qu'elle est bien loin d'être la même dans tous les individus hybrides provenant d'un même origine, et il y a entre eux, une très grande diversité."—Sageret, A., "Considérations sur la production des hybrides, des variantes et des variétés, en général, et sur celles de la famille des Cucurbitacées en particulier." *Annales des sciences naturelles,* Vol. 8, 1826, p. 302.

[21] "Tous ces faits vont s'expliquer naturellement par la disjonction de deux essences specifiques dans le pollen et les ovules de l'hybride."

results in terms of numerical ratios as did Mendel. Knight[22] and Gärtner[23] as well as Wichura,[24] Godron[25] and Vilmorin[26]

"Supposons, dans la Linaire hybride (*L. vulgaris* × *L. purpurea*) de première génération, que la disjonction se soit faite à la fois dans l'anthere et dans le contenu de l'ovaire; que des grains de pollen appartiennent totalement à l'espèce du père, d'autres totalement a l'espèce de la mère; que dans d'autres grains la disjonction soit nulle ou seulement commencée; admettons encore que les ovules soient, au même degré, disjoints dans le sens du père et dans le sens de la mère; qu'arriverat-il lorsque les tubes polliniques descendront dans l'ovaire et vont chercher les ovules pour les féconder? Si le tube d'un grain de pollen, revenue à l'espèce du père, recontre un ovule disjoint dans le même sens, il se produira une fécondation parfaitement légitime, dont le resultat sera une plante entièrement retournée à l'espèce paternelle."

Naudin, Ch., "Nouvelles recherches sur l'hybridité dans les végétaux," *Nouvelles archives du muséum d'histoire naturelle de Paris,* Vol. 1, 1865, pp. 150, 153.

[22] "Blossoms of a small white garden pea, in which the males had previously been destroyed, were impregnated with the farina of a large clay-coloured kind with purple blossoms. The produce of the seeds thus obtained were of a dark gray colour, but these having no fixed habits, were soon changed by cultivation into a numerous variety of a very large and extremely luxuriant white ones, which were not only much larger and more productive than the original white one, but the number of seeds in each pod were increased from seven to eight, to eight or nine, and not unfrequently, in one variety to ten. The newly made gray kinds I found were easily made white again by impregnating their blossoms with the farina of another white kind. In this experiment some of the seeds in the same pod would produce gray, and others white offspring, as occurs frequently in animals, which bring many young ones at birth, when the breeds of the male and female are of different colours."

Knight, T. A., "A Treatise on the Culture of the Apple and Pear, and on the Manufacture of Cider and Perry." Ludlow, 1801, pp. 37–38, footnote.

[23] "Het allerduidelijkst evenwel is de invloed van het vreemde stuifmeel op de eitjes in dit opzigt bij de *Leguminosen,* wanneer b. v. de stempel van *Pisum sativum luteum* met het stuifmeel van *Pisum sativum viride* bestoven wordt, zoo ontstaan in deszelfs peulen zaadkorrels welke aan die der moeder gelijk zijn, doch andere van eene groene en nog andere van eene gevlekte, dat is, van eene groene en gele kleur. Deze zaadkorrels uit de eerste voortteling, zoowel de groene als de gele en de gevlkte, geven in de tweede voortteling peulen, die hetzelfde verschil, als die uit de eerste voortteling, opleveren."

Gärtner, C. F., "Beantwoording der Prysvraag over bastardeering," *Natuurkundige Verhandelingen van de Hollandsche Maatschappy der Wetenschappen te Haarlem,* Vol. 24, 1838, p. 52.

[24] Wichura, Max, "Die Basterdbefruchtung im Pflanzenreich, erläutert an den Bastarden der Weiden," Breslau, 1865.

also seem to have come very near to the discovery of Mendel's principles.

III. The Law of Recombination[27]

This law is based upon the following Mendelian principle ("Versuche," etc., p. 22):

> Die Nachkommen der Hybriden, in welchen mehrere wesentlich verschiedene Merkmale vereinigt sind, stellen die Glieder einer Combinationsreihe vor, in welchen die Entwicklungsreihen für je zwei differirende Merkmale verbunden sind.

This principle may be thus translated:

> The progeny of hybrids, in which several essentially different characters are combined represent the terms of a series of combinations, in which the development series for each pair of differentiating characters are united.

Spillman in his recent paper entitled "The Application of Some of the Principles of Heredity to Plant Breeding,"[28] thus concisely states this law:

> In the second generation of a hybrid there tends to occur every possible combination of the original parent characters.

This law was also discovered by Spillman independently in 1901 and announced provisionally by him in a paper read before the Association of American Agricultural College and Experiment Stations in November of that year.[29]

The clearest and most comprehensive account of Mendel's work extant is probably that of Bateson[30] in which may be found a full discussion of the doctrine of Mendelism together with a translation in English of Mendel's original papers. The French

[25] Godron, D. A., "De l'espèce et des races dans les êtres organisés," 2d ed., Vol. 1, Paris, 1872, pp. 180–266.

[26] Vilmorin, H., "Note sur une expérience relative à l'étude de l'hérédité dans les végétaux," Paris, 1879, pp. 1–11. Extrait des mémoires de la société nationale d'agriculture de France—Année 1877.

[27] "Gesetz der Selbständigkeit der Merkmale," Correns, *l. c.*, p. 208.

[28] Bulletin No. 165, Bureau of Plant Industry, U. S. Dept. Agriculture, 1909, p. 22.

[29] Bulletin No. 115, Office of Experiment Stations, U. S. Dept. Agriculture, 1902, p. 88.

[30] Bateson, W., "Mendel's Principles of Heredity," Cambridge, 1909.

translation by Chappellier,[31] and also the recent works by Baur,[32] Haecker,[33] and Goldschmidt,[34] will be found very useful to the general student of Mendelism.

W. W. Stockberger

U. S. Department of Agriculture

[31] Chappellier, A., "Recherches sur des hybrides végétaux (Traduction française). *Bulletin Scientifique de la France et de la Belgique,* Vol. 41, 1907, pp. 371–420.

[32] Baur, E., "Einführung in die experimentelle Vererbungslehre," Berlin, 1911.

[33] Haecker, V., "Allgemeine Vererbungslehre," Braunschweig, 1911.

[34] Goldschmidt, R., "Einführung in die Vererbungswissenschaft," Leipzig, 1911.

Compliments of writer

W. M. Strobelberger

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A LITERARY NOTE ON THE LAW OF GERMINAL CONTINUITY

THE distinctive theory of germinal continuity or continuity of the germ-plasm is, historically speaking, of much more recent origin that the broader doctrine of genetic continuity from which it was derived and with which, in the usage of some writers, it is made synonymous. Genetic continuity in its widest sense embodies the proposition that "living matter always arises by the agency of preexisting living matter,"[1] and in a more restricted sense means that all living cells must be derived by continuous lineage from the cells of preexisting generations. The theory of germinal continuity, in its most highly developed form, conceives the germinal protoplasm as dividing into two portions, from one of which the somatic or body cells of the offspring are developed while the other portion is reserved unchanged for the formation of the reproductive material of the adult individual. The general doctrine of continuity is fundamentally essential to both these theories, but germinal continuity, at least in any Weismannian sense, always involves the further assumption of a transmission from generation to generation of an unmodified residue of the specially organized germinal substance, the germ-plasm, through a definite series of cells, but this concept does not imply that there is necessarily a direct connection between the germ-cells of consecutive generations.

To Richard Owen the credit is usually given of being the first to recognize the distinction between body-cells and germ-cells and thus to foreshadow the idea of germinal continuity. Writing in 1849, he said:

> Not all the progeny of the primary impregnated germ-cell are required for the formation of the body in all animals: certain of the derivative germ-cells may remain unchanged and become included in that body which has been composed of their metamorphosed and diversely combined or confluent brethren: so included, any derivative germ-cell or the nucleus of such may commence and repeat the same processes of growth by imbibition, and of propagation by spontaneous fission, as those to which itself owed its origin; followed by metamorphoses and combinations of the germ-masses so produced, which concur to the development of another individual; and this may be, or

[1] Huxley, T. H., "Lay Sermons, Addresses and Reviews," New York, 1870, p. 350.

may not be, like that individual in which the secondary germ-cell or germ-mass was included.

When the primary division of the impregnated germ-cell takes place, it must divide its properties with its matter between the two cells resulting from the spontaneous fission of its nucleus: and this result must follow every subsequent division. It is scarcely figurative therefore to say that the primary or parent germ-cell has equally divided its spermatic virtue amongst its countless progeny.[2]

Owen's suggestions apparently received no consideration and were later disregarded by the author himself. Somewhat similar ideas were expressed by Haeckel[3] in some of his earlier speculations. Galton, says Weismann,[4] was the first to express ideas resembling the theory of germinal continuity, but these ideas were later considerably modified.[5]

A clear expression of the conception of germinal continuity is found in the writings of Jäger, but his ideas made little impression, and inaccurate citation of his work has sometimes caused his disparagement. In 1877, restating previously expressed propositions, he said:[6]

The basis of heredity consists in this, that throughout whole series of generations the germ-protoplasm of animals retains unchanged its specific quality in spite of all external influences. In the actual ontogeny the available germ-protoplasm may divide into two groups, the *ontogenetic*, from which the existing individual is formed, and the *phylo-*

[2] Owen, Richard, "On Parthenogenesis," London, 1849, pp. 5–6, 63–64.

[3] Haeckel, E., "Generelle Morphologie," 1866, pp. 287–289.

[4] Weismann, A., "The Germ-plasm, A Theory of Heredity," New York, 1902, p. 198.

[5] Galton's early ideas were expressed as follows:

"From the well-known circumstance that an individual may transmit to his descendants ancestral qualities which he does not himself possess, we are assured that they could not have been altogether destroyed in him, but must have maintained their existence in a latent form. Therefore each individual may properly be conceived as consisting of two parts, one of which is latent and only known to us by its effects on his posterity, while the other is patent, and constitutes the person manifest to our senses.

"The adjacent and, in a broad sense, separate lines of growth in which the patent and latent elements are situated, diverge from a common group and converge to a common contribution, because they were both evolved out of elements contained in a structureless ovum, and they, jointly, contribute the elements which form the structureless ova of their offspring."—Galton, F., "On Blood-relationship," *Proceedings of the Royal Society of London*, Vol. 20, 1872, p. 394.

[6] Jäger, G., "Physiologische Briefe," *Kosmos*, Jahrg. I, Bd. I, 1877, p. 17.

genetic, which is reserved until the time of puberty for the formation of the reproductive material. This reservation of the phylogenetic material I designated as the Continuity of the Germ-protoplasm.[7]

This clear expression of the doctrine of germinal continuity apparently does not appear in Jäger's later work,[8] to which reference is usually made.

Weismann in his essay on the "Continuity of the Germ-plasm,"[9] assumed that he was the first to give expression to this conception but in a later work[10] made acknowledgments to other authors who had anticipated his theory. With respect to Jäger, however, he said:[11]

The praiseworthy attempt to do justice to my predecessors in this particular subject has perhaps been carried too far. In Geddes and Thompson's "Evolution of Sex" (p. 93), for instance, a quotation is given from Jäger which seems to prove that he anticipated me with regard to the theory under consideration. The quotation in which this idea is expressed is, however, not taken from the book published in 1878 but from an essay written ten years later, and it concludes with the following words: "This reservation of the phylogenetic material I described as *the continuity of the germ-plasm.*" But no mention is made by Jäger of the continuity of the germ-plasm in his book which ap-

[7] The original language of these statements is as follows: "In der 'Zeitschrift für wissenschaftliche Zoologie' Bd. XXVII habe ich unter den Titel 'Ueber die Bedeutung der Geschmak- und Geruchstoffe' ein Erörterung der chemischen Seite der Vererbungsfrage gegeben, nachdem ich schon vorher in meinen 'Zoologischen Briefen' der physikalischen Seite einige Betrachtungen gewidmet hatte. Ich will es um Folgenden versuchen, dieser Frage einige neue Anhaltspunkte abzugewinnen und das dort Gesagte zu ergänzen.

"Meine früheren Auseinandersetzungen gingen dahin: Das Fundament der Vererbung besteht darin, dass durch grosse Reihen von Generationen hindurch das Keim Protoplasma eines Thieres eine sich stets gleichbleibende spezifische Beschaffenheit allen Anfechtungen von aussen zum Trotz bewahre. Ich sagte: Bei der jedesmaligen Ontogenese scheide sich das verfügbare Keimprotoplasma in zwei Gruppen, die *ontogenetische,* aus welcher das jeweilige Individuum aufgebaut wird und die *phylogenetische* welche reservirt werde, um zur Zeit der Geschlechtsreife die Fortpflanzungstoffe zu bilden. Diese Reservirung des phylogenetischen Materials bezeichnete ich als Continuität des Keimprotoplasmas."

[8] Jäger, G., "Lehrbuch der allgemeinen Zoologie," Leipzig, 1878, II Abtheilung.

[9] "Der Continuität des Keimplasmas," Jena, 1885; Essay IV in authorized translation, 2d ed., 1891, p. 163.

[10] "The Germ-Plasm, A Theory of Heredity," New York, 1902, pp. 198–202.

[11] *L. c.,* p. 200, footnote.

peared in 1878, in which a connection between the germ-*cells* of different generations is supposed to exist:—and this is not the case. The entirely new statement of his ideas has been influenced by those contained in my essays which had appeared in the meanwhile.

As a matter of fact the quotation from Jäger which Weismann repudiates actually appeared more than eight years before the publication of Weismann's essays, as the quotation from *Kosmos,* given above, clearly shows. Although Jäger coined the expression "Continuity of the Germ-plasm," the idea involved seems to have attracted no attention until after the essays of Weismann had aroused general scientific interest.

Jäger also assumed a material connection between the germ-*cells* of different generations,[12] and, in what Weismann characterizes as "a few casual remarks," Rauber[13] expressed a conception which some authors interpret as the same idea.

In the account of his exhaustive researches on the differentiation of the reproductive cells Nussbaum gave clear expression to the doctrine of the continuity of the germ-*cells,* which in a strict sense means that germ-cells arise directly from one another. The views held by Nussbaum[14] were in part set forth in the following words:

[12] See preceding quotations from Weismann.

[13] Rauber, A., "Formbildung und Formstörung in der Entwicklung von Wirbelthieren," *Morphologische Jahrbuch,* Vol. 6, 1880, p. 4. The "casual remarks" are as follows:

"Die beiden Theilstücke, deren Verbindung das neue Wesen bewirkt, sind bei den höheren Thierformen enthalten in besonderen Organen, den Keimdrüsen. Da aber die Keimdrüsen die folgende Generation beherbergen, so erscheint ein Individuum als der Träger zweier Generationen, seiner eigenen sowie der folgenden Generation. Insoweit er der Träger seiner selbst ist, stellt er eine Person im engeren Sinne dar; er ist der *Personaltheil* der dualistischen Anlage. Die Träger der Zukünftigen Generation, die Keimdrüsen, stellen dagegen den *Germinaltheil* der dualistischen Anlage dar.

"Personal- und Germinaltheil gehen aber von *einem* befruchteten Ei aus, *ein* solches Ei enthält den Stoff mit dem Kräfteplan zu der genannten dualistischen Anlage. Man kann darum auch von einem Personaltheil und Germinaltheil des befruchteten Eies reden."

[14] Nussbaum, M., "Zur Differenzierung des Geschlechts im Thierreich," *Archiv für mikroskopische Anatomie,* Bd. 18, 1880, p. 112. The text of the original is worded thus:

"Es theilt sich demgemäss das gefurchte Ei in das Zellenmaterial des Individuums und in die Zellen für die Erhaltung der Art. In beiden Theilen geht die Zellenvermehrung continuirlich weiter; nur tritt im Leibe des Individuums die Arbeitstheilung hinzu, während in seinen Geschlechtszellen sich eine einfache additionelle Theilung vollzieht. Die beiden Zellen-

The segmented ovum divides into the cell-material of the individual and into the cells for the preservation of the species. In both divisions the cell-multiplication proceeds continuously, but in the body of the individual division of labor occurs, while in the reproductive cells simple division only takes place. Both groups of cells and their offspring are propagated quite independently of each other, so that the reproductive cells have no share in the development of the tissues of the individual, and no seminal or ovicular cell arises from the cell-material of the individual. After the segregation of the reproductive cells the history of the individual and that of the species are entirely distinct, and because of this relation the "constancy" of the species is more easily understood; that is, the sharp persistence of the phenomenon of atavism by means of which ancestral traits are transmitted. For sperm and ovum are not derived from the cell-material of the parent organism, but have a common origin with it. However, since they are preserved within it, they are subject to the conditions which modify the parent organism; therefore the transmission of "acquired" characteristics is not excluded.

Nussbaum is said by some to be the first to suggest the idea of the cellular continuity of successive generations, but this conception is clearly implied in Virchow's aphorism[15] ''omnis cellula a cellula,'' and was fully stated in 1858 in the Law of Genetic Cellular Continuity first clearly formulated by Virchow[16] as follows:

Just as an animal can originate only from an animal and a plant only from a plant, so every cell must arise from a preexisting cell. Although there are individual cases in which strict proof is still wanting, yet the principle is firmly established that for all living beings, whether they be entire plants or animal organisms or integrant parts of the same, there exists an eternal law of *continuous development.*

gruppen und ihre Abkömmlinge vermehren sich aber durchaus unabhängig von einander, so dass die Geschlechtszellen an dem Aufbau der Gewebe des Individuums keinen Antheil haben, und aus dem Zellenmaterial des Individuums keine einzige Samen- oder Eizelle hervorgeht. Nach der Abspaltung der Geschlechtszellen sind die Conti des Individuums und der Art völlig getrennt, und wir glauben aus diesem Verhalten die 'Constanz' der Art, d.h. die in der Erscheinung des Atavismus gipfelnde Zähigkeit, mit der sich die Eigenthümlichkeiten der Vorfahren vererben, begreiflicher zu finden. Denn Samen und Ei stammen nicht von dem Zellenmaterial des elterlichen Organismus ab, sondern haben mit ihm gleichen Ursprung; da sie aber in ihm aufbewahrt werden, so sind sie auch den Bedingungen unterworfen, welche auf den elterlichen Organismus modificirend einwirken, weshalb die Vererbung der 'erworbenen' Eigenschaften nicht ausgeschlossen ist.''

[15] *Archiv für Pathologische Anatomie,* Bd. 8, 1855, p. 23.

[16] ''Die Cellularpathologie im ihrer Begründung auf physiologische und pathologische Gewebelehre,'' Berlin, 1858, p. 25.

On the other hand, to Nussbaum is sometimes credited the theory of germinal continuity, but in such cases authors apparently do not sharply distinguish continuity of the germ-*plasm* from continuity of the germ-*cells.* Thus Minot[17] says:

> We owe to Moritz Nussbaum the theory of germinal continuity—the only theory of heredity which seems tenable at the present time. According to this theory, the germ-cells are set aside during the segmentation of the ovum and preserve the essentially undifferentiated qualities of the protoplasm and nucleus of the ovum, from the division of which they arise.

However, irrespective of the conclusions that may be reached as to whom priority in the statement of the theory of germinal continuity belongs, it is to Weismann that credit must be given for the development of this doctrine into an important theory of heredity.

There would seem to be a gain in precision and clearness of expression in discussions involving the idea of continuity in development if a distinction were always made between (1) *genetic continuity, or biogenesis,* (2) *genetic cellular continuity,* (3) *continuity of the germ-cell* and (4) *germinal continuity.* Thus restricted the term germinal continuity expresses more closely the conception held by the greatest exponent of this theory. Since Jäger first used the phrase "Continuity of the Germ-plasm" I suggest that his name be linked with that of Weismann in referring to this principle, which may well be called the Jäger-Weismann Law of Germinal Continuity, the esential doctrine of which is thus expressed:[18]

> In each ontogeny, a part of the specific germ-plasm contained in the parent egg-cell is not used up in the construction of the body of the offspring, but is reserved unchanged for the formation of the germ-cells of the following generation.

However, the real significance of Weismann's theory of germinal continuity and its bearing on theories of heredity can not be fully appreciated without at least a general acquaintance with the somewhat voluminous literature of this subject.

W. W. Stockberger

Bureau of Plant Industry,
Washington, D. C.

[17] Minot, C. S., "Laboratory Text Book of Embryology," Philadelphia, 1910, p. 28.

[18] Weismann, A., "Essays upon Heredity and Kindred Biological Problems," authorized translation, 2d edition, Oxford, 1891, p. 170.

3. Versteuerte Malzmengen, nach dem Steuersatze geordnet.

		4 M.	4.50 M.	5 M.	5.50 M.	6 M.	6.50 M.	7 M.	8 M.	9 M.	10 M.
		D	o	p	p	e	l	z	e	n	t n e r
1. P[illegible]	1906/07	1 858 348	186 159	325 603	506 511	365 191	289 494	231 940	190 563	165 295	1 827 514
	1907/08	556 979	379 621	565 617	761 787	511 922	387 224	301 508	242 599	196 987	1 945 536
2. [illegible]	1906/07	232 847	36 394	54 841	71 007	43 138	29 029	21 730	18 659	13 911	233 368
	1907/08	97 275	56 914	76 228	91 539	55 115	38 646	30 200	25 947	19 747	276 488
3. [illegible]	1906/07	94 592	8 221	16 929	26 504	16 013	11 066	10 398	8 287	7 218	105 761
	1907/08	22 994	18 008	28 395	37 942	24 555	17 421	14 [illegible]17	11 078	10 475	112 488
4. [illegible]rg	1906/07	25 321	6 120	9 795	7 123	2 786	2 100	2 000	1 840	1 593	12 735
	1907/08	13 636	9 089	12 192	10 427	3 699	3 000	3 000	2 734	1 940	12 666
5. [illegible]	1906/07	164 548	25 924	51 842	70 921	38 959	29 930	20 010	15 397	12 075	51 558
	1907/08	83 456	48 497	72 633	91 547	47 767	33 003	22 791	17 113	13 745	50 977
6. [illegible]	1906/07	12 179	1 657	3 764	7 367	5 159	3 575	867	—	—	—
	1907/08	6 158	3 836	6 174	8 227	5 114	3 000	1 505			
7. [illegible]weig	1906/07	35 316	1 727	3 025	4 380	4 350	5 660	7 090	7 397	7 000	29 733
	1907/08	7 291	4 907	7 572	13 464	9 981	9 000	8 538	7 993	6 150	27 915
8. [illegible]	1906/07	30 033	2 163	3 933	5 981	4 532	2 058	1 730	1 000	331	38 803
	1907/08	7 347	4 429	6 166	7 437	4 861	2 893	1 623	1 250	970	52 165
9. [illegible]	1906/07	7 212	837	546	2 831	3 013	1 954	1 000	790	—	—
	1907/08	3 414	1 552	2 100	4 000	3 297	2 420	1 140	1 000	390	—
10. [illegible]	1906/07	21 062	—	457	2 810	5 477	5 555	4 725	4 952	5 000	21 901
	1907/08	2 243	2 191	4 452	8 968	8 823	7 283	6 061	4 980	4 640	24 927
11. H[illegible]	1906/07	41 627	301	1 169	2 012	2 989	5 164	7 405	9 052	9 366	55 145
	1907/08	4 245	3 756	6 707	12 646	11 376	11 398	10 550	10 390	9 388	53 226
12. [illegible]g	1906/07	48 648	—	—	—	—	—	—	—	—	—
	1907/08	3 003	2 814	5 355	8 425	7 457	5 911	4 665	2 790	2 000	6 215
Br[illegible]gemeinschaft	1906/07	2 523 096	269 503	471 904	707 447	491 607	386 085	308 895	257 937	221 819	2 379 548
	1907/08	808 065	535 614	793 591	1 056 409	693 965	521 199	405 801	327 874	266 441	2 562 453

(Schluß folgt.)

Die No[illegible]digkeit neuer Normen für die Bewertung des Hopfens in Amerika.

Von [illegible]fdberger, Pharmakognost für Drogenpflanzen-Untersuchung, Bureau für Pflanzenindustrie, Ver. St. Dept. für Landwirtschaft*).

[illegible] der Untersuchungen über Hopfenbau und Hopfenbehandlung hat es sich herausgestellt, daß großer Mangel an Einheitlichkeit [illegible]nden herrscht, auf Grund deren die Hopfenkäufer das Produkt [illegible]nige Käufer betrachten die Provenienz als den entscheidenden [illegible]e die aromatischen Eigenschaften, andere das Aussehen, während [illegible] verschiedene Kombinationen dieser Eigenschaften annehmen. Es [illegible] für dieses wichtige Erzeugnis der Landwirtschaft keine allgemein [illegible]rundlage zur Bestimmung des wirklichen Wertes. Dies ist auf [illegible]mstände zurückzuführen, welche hier nicht erörtert werden können. [illegible]nicht wäre, eine gemeinsame Grundlage zu finden, wird nicht [illegible]rika, sondern auch in Europa zugestanden. Die folgende Ab[illegible] dazu beitragen, Ordnung in diese Angelegenheit zu bringen.

Einleitung.

Obgle[i]ch bestimmte Normen zur Beurteilung der Qualität des Hopfens als erwünscht anerkannt worden sind, haben gewisse praktische [illegible] der Verwirklichung des Gedankens bislang im Wege gestanden. [illegible] Hindernissen ist keineswegs am unwichtigsten der Umstand, daß [illegible]igen darüber, was Qualität ausmacht, sowie über die Natur [illegible]nichte Menge der verschiedenen Bestandteile eines entschieden [illegible] Hopfens weit auseinandergehen. Teilweise infolge der [U]ngewißheit in Bezug auf eine Grundlage für die Beurteilung und teilweise infolge des Vorteiles, den ein lange eingeführtes [illegible]ner gewissen Lage gewöhnlich vor dem gleichen Produkte aus einer neuen Gegend voraus hat, legen viele Konsumenten alle anderen Erwägungen fast ganz beiseite und kaufen ausschließlich auf Grund der Provenienz. Eine sorgfältige Prüfung der Hopfenernten in den ver[s]chiedenen hopfenbauenden Gegenden kann nur zu dem Schlusse führen, daß die Beurteilung der Qualität auf Grund der Provenienz allein in vielen Fällen zum Nachteil des Konsumenten und in vielen anderen zum Nachteile des Produzenten ausfallen muß. Der Unterschied in der Qualität von Hopfen aus Gärten, die nur wenige Meilen voneinander entfernt liegen, kann bedeutend größer sein als derjenige zwischen ausgewählter Ware aus zwei oder mehr weit auseinanderliegenden Gegenden. Es liegt guter Grund für die Ansicht vor, daß diese Tatsache im Hopfenhandel wohl bekannt ist, weil die berichteten Verkäufe von Hopfen aus gewissen Gegenden, die sich eines guten Rufes erfreuen, mehreremal größer erscheinen als die Produktion in denselben Hopfen, welche als minderwertig angesehen würden, wenn ihre Provenienz bekannt wäre, können sehr günstige Beurteilung finden, wenn sie als aus einer Gegend kommend angepriesen werden, welche den Ruf genießt, Hopfen feiner Qualität zu erzeugen. Durch lange Erfahrung kann große Geschicklichkeit in der Erkennung der mutmaßlichen Provenienz einer Hopfenprobe erreicht werden. Es gibt sogar Leute, welche behaupten, imstande zu sein, nach der praktischen Prüfung einer Hopfenprobe genau die Oertlichkeit oder das Flußtal anzugeben, in welchem der Hopfen erzeugt wurde. Hierin mögen sie wohl zuweilen Glück haben, bei den minderwertigen Sorten oder wenn ein sekundärer Faktor vorhanden ist, der auf einer eigentümlichen Darrmethode oder sonstigen Behandlungsweise beruht, aber im allgemeinen können sie damit nicht Recht haben, denn ein solches nur auf oberflächlicher Aehnlichkeit beruhendes Urteil kann immer nur Raten sein. Wie übertrieben diese Behauptungen oft sind, zeigte sich in einem Falle, der dem Verfasser persönlich aufstieß. Ein Mann von umfangreicher, langjähriger Erfahrung in der Hopfenindustrie stellte in gleicher Weise eine Reihe Proben Hopfen aus den hauptsächlichsten hopfenbauenden Gegenden Amerikas her. Die Proben

*) [illegible]r „American Brewers' Review" (1909, Nr. 8).

[illegible]pazierstock übers Gesicht, daß die Fetzen flogen. Die Schöffen, vor denen [illegible]ließlich zur Verhandlung kam, würdigten verständnisvoll die große [illegible]treitenden, und der freiwillige Hofbrauhaxenanwalt kam mit 10 M. Körperverletzung davon. Die Haxen aber kosten im Hofbrauhaus, wie [illegible]chtsforscher nicht vergessen wollen beizufügen, 70 Pf. gedünstet und

*

[illegible] **Bierpreise in früheren Zeiten.** Schon von jeher war das Bier für [illegible]ebender Faktor, und immer hatte eine Preiserhöhung desselben eine große Erregung verursacht. Die Chronisten führten auch über die Bier[illegible]uch, sodaß man in der Lage ist, auf Grund der Karcheschen Chronik die [illegible] Zeiten zur Kenntnis zu bringen. Es kostete eine Maß Bier im [1]523 2 Pf., 1532 2.5 Pf., 1619 5 Pf., 1622 6 Pf., 1637 [illegible] Batzen, 1757 [illegible], 1763 7 Pf., 1766 7 Pf., 1769 6 Pf., 1770 7 Pf., 1771 9 Pf., 1772 [illegible] 1774 6 Pf., 1785 7 Pf., 1796 8 Pf., 1799 10 Pf., 1803 im Sommer 10 Pf., 1806 10 Pf., 1816 5 Kreuzer, 1817 6 Pf., 1818 10 Pf.

*

[illegible] **Getränkerechnung. John Bull wird immer mäßiger.** Er hat [illegible] alkoholhaltige Getränke nur 161060482 £, d. h. über 3300 Millionen [illegible]n, denn diese Ausgabe war immerhin, wie der Temperenz-Apostel [illegible]ns in der Getränkerechnung ausrechnet, die er John Bull jedes Jahr [illegible]rlegt, um 5935718 £ (etwa 120 Millionen Mark) kleiner als im Vorjahr. [illegible]klärt sich zum Teil durch die wirtschaftliche Depression; er steht übrigens [illegible] der letzten Jahre in Uebereinstimmung. Die Durchschnittsausgabe für [illegible]tes Jahr auf den Kopf der Bevölkerung 72.26 M. und für eine Familie [illegible]n 361.30 M., gegenüber 75.72 M. und 378.60 M. im Jahre 1907. Von [illegible]onen £ hat John Bull 50[illegible] Millionen £ für 38 Millionen Gallonen [illegible]llone = 4.544 Liter) ausgegeben, 99 Millionen £ für 33 Millionen [illegible]rrel = 163.57 Liter), 10 Millionen £ für 11 Millionen Gallonen Wein [illegible] Millionen £ für etwa 15 Millionen Gallonen Most, britische Weine usw. [illegible]ch Irland, wo der Bierverbrauch den Schnapsverbrauch verdrängt hat, [illegible].7 und 20.5 Gallonen Bier auf den Kopf gegenüber 0.8 und 0.9 Gallonen [illegible] biertrinkende Länder, während in Schottland 1.5 Gallonen Schnaps und [illegible]er auf den Kopf kommen. Die konsumierten Getränke enthalten im ganzen [illegible]en reinen Alkohol, was immerhin 1.8 Gallonen auf den Kopf der Be[völk]erung [illegible].

*

K[illegible]rin: „Herr Doktor, der Wirt meint, Sie möchten auch mal ans Bezahlen [illegible]"

Student: „Sagen Sie dem Wirt, daß ich das ewig tun werde."

*

„[illegible] weiß ich nicht: Hat mei Alte g'sagt, ich soll nur zwei Maß trinken und um [illegible]n, oder hat sie g'sagt, ich soll zwölf Maß trinken und um zwei dahelm [illegible]"

*

Sonst nannte man es Bier und Wein
Und labte dran sich redlich,
Jetzt heißt es chemisch Alkohol,
Jetzt ist die Sache schädlich.

O weh, du armer Gerstensaft,
Du goldnes Rebenblut,
Ihr seid jetzt giftiges Präparat!
Was doch solch Name tut!

Ich streite und ich hadre nicht,
Ich füg' mich dem Gebot.
Doch weil mir nichts mehr Freude macht,
Trink ich an euch mich tot

*

Sein erster Gedanke. Bierbrauer Gerst[illegible] vor den Pyramiden: „Sag'n [illegible] ama' dös san g'wiß alte egyptische Lagerkeller?"

*

Hias: „Was is denn dös: ‚alkoholfreie Getränke'?"

Michel: „Woaßt, dös san solchene, von dö, wennst das trinkst, koan Rausch [illegible] kriegst."

Hias: „Na, zweng was trinkt man denn nacha?"

*

Der Herr Professor, ein Verfechter der absoluten Alkohol-Enthaltung, ist [illegible] München berufen worden. Die Frau Professor hat eine Köchin angenommen; nachdem mit dieser alles verabredet ist, sagt die Frau Professor: „Und schließlich noch eines: in unserem Hause darf kein Alkohol getrunken werden, Sie müssen also auf das [illegible] übliche Bier verzichten!"

„'s ischo recht", sagte die Köchin, „i bin früher [illegible] amal in so aner g'rett[illegible] Säuferfamilie gewesen!"

*

Student (zu seiner Wirtin): „Holen Sie mir doch [illegible] Maß Bier, ich [illegible] heut' zu Hause!"

*

In der Schulprüfung fragt der Inspektor ein Mädchen nach den fünf Sinnen. Es zählt auf: „1. das Gesicht, 2. das Gehör, 3. der Geruch, 4. das Gefühl, 5. der — das [illegible]" Der Lehrer, bekannt als Stammgast in der Brauerei, steht gerade hinter dem Inspektor, und will dem Kind daraufhelfen, indem er mit der Hand nach dem Munde zeigt. Sofort vollendet das Mädchen: „5. der Durscht".

*

„Wie gefällt's Euch denn in Euerem neuen Singlokal?"

„„Vorzüglich; die Akustik ist brillant und das Bier außerdem so gut, daß wir meistenteils abends gar nicht zum Singen kommen!"

*

Richter: „Woraus schließen Sie, daß jener rätselhafte Fahrgast ein Fremder gewesen sein müsse?"

Kutscher: „Er hat mich g'fragt, ob ich vielleicht eine Maß Bier trinken möcht'!.. Herr Amtsrichter, so dumm fragt a Hiesiger net."

*

waren alle von guter Qualität, und ausgesprochene äußerliche Fehler wurden absichtlich vermieden. Diese Proben wurden dann bezeichnet und einer Anzahl erfahrener Hopfenkenner nacheinander vorgelegt. Nicht ein einziger war imstande, die Proben richtig zu bezeichnen. Und selbst der Mann, welcher die Proben hergestellt hatte, konnte sie ohne Hilfe der Bezeichnung nicht richtig erkennen. Diese und ähnliche Erfahrungen zeigen deutlich, daß auf die Provenienz als ein Kriterium der Qualität zuviel Gewicht gelegt wird.

Die herrschenden Methoden der Bewertung.

Fast ausnahmslos verkauft der Produzent seinen Hopfen auf Grund einer empirischen physikalischen Prüfung, der Konsument dagegen, welcher von einem Händler oder Makler kauft, unterwirft seine Proben oft nicht allein einer physikalischen, sondern auch einer chemischen Prüfung. Die bei der Beurteilung der Qualität in Betracht kommenden Punkte sind zahlreich und weichen je nach individuellen Anschauungen weit voneinander ab. Die wichtigsten sind: Aroma oder Geruch, Farbe, Quantität, Lupulin, Dicke, Darren, Pflücke, Abwesenheit von Blättern und Stielen usw., Abwesenheit von Schimmel und Insekten, Menge der zerbrochenen Dolden, Menge der Samen, Reife, Weichheit des Gewebes, Seidigkeit, Klebrigkeit oder Oeligkeit, Flockigkeit, Größe der Dolden, Grad der Schwefelung und das Ausfühlen. Gewisse Punkte, wie die Anwesenheit von Blättern und Stielen, Schimmel, Insekten, Fehlen des Lupulins, zerbrochene Dolden, dumpfer oder saurer Geruch, gelten allgemein als nachteilig für die Qualität und lassen sich meist leicht durch Besichtigung feststellen. Das Verhältnis solcher Merkmale, wie Aroma, Farbe, Größe der Dolden usw., zur Qualität hängt ganz und gar von der Vorliebe des Individuums ab und wird nach keiner allgemeinen Norm bestimmt. Das Urteil wird gebildet nach dem Eindruck des Hopfens auf Auge, Nase und Gefühl und gibt daher kein quantitatives Maß für die charakteristischen Merkmale des Hopfens.

In Deutschland ist man einer einheitlichen Methode bereits nähergekommen durch die Annahme von Schemas oder Karten, auf denen gewisse relative Werte gewissen Eigenschaften beigelegt werden. Im folgenden geben wir das Schema, nach welchem die Beurteilung des Hopfens auf der Ausstellung für Braugerste und Hopfen für Baden in Augustenberg im Oktober 1907 stattfand:

Entwicklung der Dolden	Qualität und Quantität des Lupulins	Aroma	Farbe	Pflücke	Darren	Sorten	Gesamtzahl der Punkte (größtmögliche Zahl 27)
Anzahl der Punkte für jedes Bewertungselement							
5	5	5	3	3	3	3	

Viele ähnliche Pläne sind in Vorschlag gebracht worden, doch beruhen sie alle schließlich auf dem individuellen Geschmack oder der persönlichen Vorliebe.

Weit weniger Wichtigkeit scheint der chemischen Analyse als Mittel zur Bestimmung der Qualität beigemessen zu werden. Wenn diese Methode befolgt wird, ist es üblich, nur solche Bestandteile zu bestimmen, welche für die wichtigsten gelten. Einige halten die Hart- und Weichharze für das Wichtigste bei der Beurteilung der Qualität und sind der Ansicht, daß in einem guten Hopfen die Weichharze mindestens dreimal so stark vertreten sein sollen wie die Hartharze; andere legen mehr Gewicht auf den Gerbsäuregehalt; wieder andere halten dafür, daß der Gehalt der Asche an Mineralstoffen, wie Kalium, Kalk und Magnesium, ein Anzeichen für die Qualität des Hopfens ist. Die chemische Beurteilung der Qualität ist also ebenso ungewiß wie die physikalische Prüfung infolge der mangelnden Uebereinstimmung über die relative Wichtigkeit der mittels dieser Methode bestimmten Bestandteile.

Mängel der herrschenden Methode.

Der größte Mangel in der Methode der physikalischen Prüfung liegt in dem Umstande, daß sie eine exakte Durchführung ausschließt. Der relative Wert, der den verschiedenen Faktoren beizulegen ist, weicht bei verschiedenen Personen erheblich ab. Obgleich dem Aroma eine so hohe Bedeutung beigelegt wird, daß es bei vielen als die höchste Probe der Qualität gilt, so kann es keine genaue Auskunft über den inneren Wert geben. Es ist endgültig nachgewiesen, daß in vielen Fällen gewisse halb unbewußte Faktoren die Schätzung des Aromas und der anderen Bestandteile des Hopfens beeinflussen. Der hauptsächlichste ist die Provenienz, welchen wir bereits besprochen haben. Ein anderer ist die An- und Abwesenheit eines bekannten physikalischen Merkmales, welches mit dem inneren Werte nichts zu tun hat, aber trotzdem das Urteil beeinflußt. Dieser Schluß drängte sich dem Verfasser auf infolge des folgenden Experimentes, welches vor mehreren Jahren in den Hopfengärten von Kalifornien angestellt wurde. Bei diesem Versuche wurde ein Korb mit Hopfen von dem Boden einer Darre gefüllt, die eben mit frischem Hopfen aus dem Garten geladen worden war, und zwar ehe Wärme oder Schwefel angestellt worden war. Dieser Hopfen wurde auf dem Fußboden eines Zimmers ausgebreitet und dort unter Ausschluß der Sonne trocknen gelassen. Nachdem der Hopfen auf der Darre in der gewöhnlichen Weise mit Hilfe von Wärme und Schwefeldämpfen getrocknet war, wurde der Korb wieder mit Hopfen von der Darre gefüllt, und zwar aus demselben Teile der Darre, welchem der erste Korb voll entnommen worden war. Die beiden Proben waren also praktisch identisch mit Ausnahme des Trockenverfahrens. Die Qualität der Harze wurde in einem Teile einer jeden der beiden Proben bestimmt, und es stellte sich heraus, daß der auf der Darre getrocknete Hopfen weniger Weichharze enthielt als der auf natürlichem Weg auf dem Zimmerboden getrocknete. Dann wurden kleine Handproben aus den beiden Körben hergestellt und vier erfahrenen Hopfenkennern vorgelegt, welche nichts über die Provenienz oder die Behandlungsweise wußten. Zwei von den Experten erklärten den gedarrten Hopfen für besser als den auf dem Zimmerboden getrockneten, die beiden anderen umgekehrt. Dieser Fall zeigt die Art und Weise der herrschenden Bewertungsmethode und die große Rolle, welche dabei die vorgefaßten Anschauungen über den Wert spielen. Es ist auch interessant, die Anschauungen zu studieren, welche in Bezug auf deutsche oder böhmische Hopfen bestehen, die sich lange des Rufes erfreut haben, den amerikanischen weit überlegen zu sein infolge des besonders feinen Aromas, das man ihnen zuschreibt. Es ist jedoch klar, daß das Verhältnis des Aromas zu den anderen Bestandteilen niemals vollständig festgestellt worden ist, man hat einfach angenommen, daß Unterschiede im Aroma qualitativ seien und bedeutende Unterschiede in der Zusammensetzung andeuteten. Es liegen Gründe für die Annahme vor, daß Unterschiede im Aroma großenteils quantitativ sind, und daß dieser Faktor nicht unbedingt ein Kriterium der Qualität des Hopfens bildet. Die mannigfaltigen Anschauungen über Hopfenaroma und Qualität und die Notwendigkeit, dieselben gründlich zu revidieren, erhellt ferner aus den folgenden Urteilen, von denen jedes von einem anderen Spezialisten in dem G[…] Beurteilung des Hopfens herstammt:

Saazer Hopfen sind die besten. Die Anschauung, daß imr […] besser sind, ist großenteils Vorurteil. Deutsche Hopfen sind […] besten. Die Kenter Hopfen sind die feinsten, sie sind besser al[…] Die Wisconsiner Hopfen sind ebenso gut wie die deutschen. […] Hopfen sind die besten wegen ihres feinen Aromas. Ein Pfund […] ist so viel wert wie drei Pfund amerikanische. Die besten N[…] sind praktisch ebenso gut wie die deutschen. Ein geriebene[…] alles verkaufen, was wie Hopfen aussieht. Weil Hopfen verschi[…] verschiedenen Geruch haben, so bildet sich natürlich individu[…] Die herrschende Methode der Beurteilung des Hopfens ist sehr […] urteil oder Geschmack spielt die größte Rolle. Die Hopfen vo[…] Küste sind stärker an konservierenden Harzen als englische […] amerikanischen Hopfen können den deutschen nie gleichkomm[…] sie bedeutend verbessert werden. Was allgemeine Qualität an[…] New-Yorker Hopfen, wenn sie mit derselben Sorgfalt gepflückt […] würden wie die auswärtigen, an Qualität ebenso gut sein wi[…] Differenzen zwischen amerikanischen, englischen und deutsche[…] fast ausschließlich eine Frage des Geruches. Die deutschen […] viel mehr Lupulin als die amerikanischen. Es bestehen gr[…] heiten in der Qualität der deutschen Hopfen. New-Yorke[…] deutschen Wurzeln sind besser als die minderwertigen […] Hopfen. Qualität hat wirklich nicht viel zu bedeuten. D[…] verkaufen, bringt mehr Erfolg als Qualität. Hopfen werd[…] eine Sorte gekauft und als eine andere verkauft. Hopfen vo[…] Küste enthalten mehr Lupulin als ausländische Hopfen. […] sind besser als deutsche. Der bessere Geruch, der dem de[…] zugeschrieben wird, ist hauptsächlich eine Sache der Vorliebe. […] haben einen besseren Geruch, sind aber nicht so viel besser als die […] wie allgemein angenommen worden ist. Die besten Hopfen vo[…] Küste sind ebensogut wie die deutschen oder böhmischen Hopfen.

Die Unsicherheit der Resultate der physikalischen Prü[…] Schwierigkeit der Beurteilung der Qualität des Hopfens hab[…] ist in Deutschland längst anerkannt worden, und man hat […] Schutzmittel angewandt, um die Echtheit bei Angaben über d[…] des Hopfens zu sichern. Daß der Hopfenhandel diese Vorurteile […] zu Nutzen macht, geht aus folgender Aeußerung von Emanuel G[…] Es wird mit Recht gewissen Händlern vorgeworfen, daß sie d[…] ihrer Hopfen fälschen. . . . Eine hervorragende Rolle wird […] zahlreichen Vereinigungen zur Sicherung einer gehörigen G[…] Provenienz von Hopfenballen gespielt. Gewissenlose Händler […] Fälschungen dieser Art Vermögen erworben, indem sie geringe S[…] seiner Saazer Hopfen kauften, mit größeren Mengen Hopfen […] Gegenden mischten . . . . und das Ganze als Saazer Hopfen ver[…]

In Deutschland und Oesterreich bestehen Bestimmungen, wo[…] versiegelt und von einem Zertifikat begleitet werden, damit ihre P[…] Interesse des Produzenten wie des Konsumenten garantiert wer[…] Regel, daß in Hopfen mit dem Namen und der Adresse des Pr[…] breiten Schichten nicht imstande sind, die Qualität des Hopfens zu […]

Notwendigkeit neuer Normen.

Ein rationeller Plan für die Veredlung einer Nutzpflanze e[…] bestimmte Norm der Qualität oder des Wertes, wonach Mängel […] klare Anschauungen darüber gewonnen werden können, in was für […] Verbesserung erwünscht ist. Der Mangel einer hohen Norm hat un[…] Spezialisierung auf größere Ertragsfähigkeit allein geführt und […] verbundene Vernachlässigung anderer Faktoren hat eher zur Ver[…] als zur Verbesserung der Qualität geführt. Anstatt Varietäten a[…] welche Hopfen feiner Qualität liefern, hat der Pflanzer solche gen[…] den größten Ertrag gaben, in dem Glauben, daß der geringere […] für die minderwertige Qualität erhielt, durch den größeren Ert[…] gleich mit den besseren Sorten mehr als wettgemacht werde. […] nicht bezweifeln, daß die unzuverlässigen Methoden der Be[…] Qualität, wie sie heute herrschen, diese Annahme wenigstens zum […] fertigen. Die schlechten Preise, welche seit mehreren Jahren geh[…] und die scheinbar allmälige Abnahme in dem Weltkonsum von […] dem Pflanzer die Notwendigkeit besserer Kulturmethoden und […] definitiver Normen klargemacht haben. Wenn, wie in dem vorlie[…] die Weltproduktion den Weltkonsum übersteigt, wird der Konsum[…] befriedigen sein und kann die besseren Sorten Hopfen verlangen u[…] Für die schlechteren Sorten findet sich kein Markt, der dem Prod[…] Nutzen verschafft. Seit Jahren hat die amerikanische Hopfener[…] forderungen des heimischen Marktes überschritten, und unter sol[…] ist es üblich gewesen, einen Markt für den Ueberschuß im Auslan[…] Auf den fremden Märkten sind die amerikanischen Hopfen mit de[…] Ländern erzeugten in Konkurrenz getreten und werden nach […] betreffenden Ländern üblichen Normen beurteilt. Der Erfol[…] amerikanischen Hopfen im Auslande erreichen, wird daher da[…] wieweit sie den Anforderungen anderer Länder genügen. Ob […] recht oder unrecht sind, Tatsache ist, daß sie festgesetzt sind und […] Erwägung der amerikanischen Pflanzer verdienen. Infolge d[…] Produktion in Deutschland und Oesterreich hat in den letzten v[…] starker Export aus jenen Ländern nach den Vereinigten Staaten […] Die Konkurrenz ist für die amerikanischen Hopfen ungünstig […] des Rufes der besseren Qualität, den die importierten Hopfen […] manche Leute bildet der eingeführte Hopfen eine Norm, m[…] anderen Hopfen verglichen werden. Dies ist eine willkürliche […] welcher nicht beachtet wird, daß große Unterschiede in der […] importierten Hopfen bestehen und wonach die Qualität große […] Provenienz bestimmt wird ohne Rücksicht auf den inneren Wer[…] sich die verschiedenen lokalen Faktoren und die Witterungsve[…] gegenwärtigt, welche die Qualität beeinflussen, so erhellt, daß die […] Methoden unzulänglich sind, um die Variationen in den Hop[…] zu bestimmen.

Ein sorgfältiges vorurteilsfreies Studium der Natur und […] Verhältnisse der Bestandteile der amerikanischen und europäische[…] dem Zweck, eine zuverlässige Grundlage für eine Bewertungsnor[…] ist, wie es scheint, noch niemals unternommen worden. Mit […] teilen des Hopfens ist sehr viel gearbeitet worden, doch ist no[…] für ein Uebereinkommen gefunden in der Auslegung des Ver[…] Bestandteile zur Qualität, außer nur in ganz allgemeiner […] gewissen Gegenden erzeugten Hopfen haben einen bedeutenden […] und es wird der Anschauung Ausdruck verliehen, daß Hop[…]

nirgends anders erzeugt werden können. Dieses ist eine sehr weit- ...ehauptung und steht im Widerspruch mit den Erfahrungen mit vielen Kulturpflanzen. Man vergißt dabei ferner oft, daß Hopfen aus ... Gegend im Aroma sehr verschieden sein können. Dieser Unterschied ... mehreren Faktoren, unter denen an erster Stelle die Varietät steht. ...rietäten besitzen ein wohlausgeprägtes und charakteristisches Aroma, ...öglichkeit der Variation in dieser charakteristischen Eigenschaft durch ...ung von Varietäten scheint sehr groß zu sein. Zweitens wird das ...rch die Zeit der Pflücke beeinflußt. Das flüchtige Oel, von welchem ...a zum großen Teil herrührt, nimmt an Qualität zu, indem der ... der Reife nähert, und daher hat der vollreife Hopfen ein stärkeres ... der unreif gepflückte. Drittens können das Darrverfahren und die ...g in dem Kühlraum eine Aenderung in dem Aroma veranlassen. ...gungen sollten den Verlaß, den man auf die Provenienz als ein ...r Bestimmung der Qualität legt, mindern. Solch große Ver...ten in den Anschauungen von der Qualität, wie die oben angeführten, ...icht existieren können, wenn es eine feste Norm gäbe, nach welcher ...tät zu messen wäre. Nicht allein geht das Urteil derer, welche sich ...alische Proben allein verlassen, weit auseinander, sondern es bestehen ...terschiede, wo die Anschauungen sich auf chemische Analyse stützen. ...esentlich, einheitliche Methoden für die physikalische und chemische ...ung des Hopfens festzustellen, gerade wie solche für die Prüfung ...derer Materialien angenommen worden sind. Normen für Qualität ...enfalls aufgestellt werden, denn eine gerechte Beurteilung kann nur ...d wohldefinierter und allgemein angenommener Prüfungsmethoden ...rden. Neue auf einer eingehenden Kenntnis der Natur und des Wertes der verschiedenen Hopfenbestandteile aufgebaute Normen sind ..., um unverdiente Unterscheidungen in dem Markte zu verhindern, ...len amerikanischen Hopfenpflanzern zum Nachteil gereichen und dem ...ten unnötige Kosten aufbürden.

Eine Bewegung für eine internationale Norm.

... großen Unannehmlichkeiten, welche für den Hopfenhandel daraus ..., daß keine zuverlässigen Ernteberichte erhältlich sind, und daß es so ..., eine zuverlässige Statistik über die im Bau befindliche Fläche und ...che Produktion zu erhalten, werden in Europa nicht weniger ge... als in Amerika. In Deutschland ist erst kürzlich eine Bewegung an...orden, welche darauf abzielt, zwischen den hopfenbauenden Staaten ...ner Länder ein internationales Uebereinkommen zu treffen, und zu... Berichte und Statistik zu schaffen. Im Verfolg dieses Planes wurde ...genheit der Internationalen Hopfen- und Gerstenausstellung in Berlin ...ber 1908 eine Konferenz aller anwesenden Vertreter von Hopfen... einberufen zum Zweck einer allgemeinen Besprechung und um die ...g eines internationalen Informationsbureaus über Produktion, Konsum ...t des Hopfens zu erörtern und Pläne für gemeinsames Vorgehen zum ...gen Nutzen der Interessenten der Hopfenindustrie zu entwerfen. Ein ... wurde ernannt, um die auf der Konferenz in Vorschlag gebrachten ...szuarbeiten und den Hopfenbauvereinen in den verschiedenen Ländern ...breiten. Auch wurde beschlossen, eine allgemeine Konferenz von Ver... der Pflanzer aller hopfenbauenden Länder gegen Ende August 1909 ...nen einzuberufen. Ferner soll auf dieser Konferenz die Aufstellung ...ernationalen Norm für die Beurteilung der Qualität des Hopfens in ...g gezogen werden. Es sind genügend Gründe angegeben worden, ... Annahme einer neuen und unparteiischen Norm der Qualität nicht ...nschenswert, sondern notwendig ist. Wenn man bedenkt, daß die ...Aufnahme amerikanischen Hopfens im Auslande von dem Wohlwollen ...andes abhängt, daß die Annahme einer internationalen Norm aus... auf Grund europäischer Anschauungen über Qualität ohne Rücksicht ... inneren Wert des amerikanischen Hopfens den amerikanischen Pflanzer ...igen würde, und daß die amerikanischen Hopfen in Bezug auf ... in ihren heimischen Märkten nach einer Norm gemessen werden, die ...Eigenschaften des aus dem Deutschen Reich eingeführten Hopfens ge...t, so scheint, es sollten die Hopfenproduzenten der Vereinigten Staaten ...egenheit nicht versäumen, sondern nach dieser Versammlung geeignete ...zu schicken, deren Aufgabe es sein sollte, darauf hinzuwirken, daß die ...ften des amerikanischen Hopfens günstiger beurteilt werden. Alles ...geboten werden, um eine gründliche Revision der Methoden der ...wertung herbeizuführen und die neue Untersuchung der Hopfenbestand...uleiten als ein vorbereitender Schritt zur Aufstellung einer inter...n Norm, die auf wirklichen inneren Wert ohne Berücksichtigung anderer ... gegründet ist. Es mag eingewendet werden, daß die amerikanischen ... in einer im Ausland abzuhaltenden Konferenz einer solchen Ueber...nüberstehen würden, daß ihre Ansichten keine volle Beachtung finden ...nd daß es daher besser sein würde, sich nicht an der Bewegung zu ... Andererseits jedoch würde keine internationale Norm ohne die Zu...sämtlicher Vertreter angenommen werden können, und eine kraftvolle ...a der Notwendigkeit einer breiteren und gründlicheren Basis für die ...g des Hopfens nicht ignoriert werden. Eine solche Handlungsweise ... der Klärung der Anschauungen über die Qualität des Hopfens führen.

C...emische Studien über amerikanische Gersten und Malze.

Von J. A. Le Clerc und Robert Wahl.

Aus B...tin Nr. 124, Vereinigte-Staaten-Departement für Landwirtschaft (hier nach „American Brewers' Review", 1909, Nr. 6).

Einleitung.

D... Bestrebungen zur Veredlung der Gerste für Brau- und Futter-...ben zu einer gründlichen Diskussion des relativen Wertes protein-...d -armer Gerste geführt und dadurch unsere Kenntnisse über diesen ...d erheblich bereichert. Auch hat der Erlaß des Gesetzes über ...ten Alkohol frischen Anstoß zum Studium der Gerste gegeben, weil ... Herstellung von Alkohol verwendet wird. Sein Wert für diesen ...uht auf seiner diastatischen Kraft, und da die Malze in dieser Hinsicht ...e Unterschiede aufweisen, leuchtet die Wichtigkeit des Studiums ...scher Gersten und Malze ohne weiteres ein.

Z...r Lösung dieser Aufgabe muß der Chemiker und der Botaniker ...arbeiten, denn es gibt hier Probleme, wie Einfluß des Bodens, der ...tel, der klimatischen Verhältnisse, der Auswahl der Saat auf die ...tät der erzeugten Gerste. Die einschlägigen Informationen sind von dem ...unkte aus zusammengestellt, dem Gerstenbauer behilflich zu sein und ...menten mit den Eigenschaften von unter verschiedenen Bedingungen ... Gersten bekanntzumachen. Die Resultate dieser Arbeit werden mit ...n anderer Forscher verglichen, und obgleich sie noch unvollständig sind, maß man ihnen genug Interesse bei, um ihre Veröffentlichung vor der Vollendung der Arbeit ratsam erscheinen zu lassen.

Ueberblick über die Literatur.

Die Literatur über Gersten- und Malzuntersuchungen enthält zahllose Mitteilungen über die Gerstensorten, welche am tauglichsten für Brauzwecke sind, doch ist verhältnismäßig wenig von dem Standpunkte der Produktion des industriellen Alkohols geschrieben worden. Protein und seine Abbauprodukte ziehen immer mehr die Aufmerksamkeit auf sich. Auf der einen Seite gibt man der proteinarmen Gerste den Vorzug und verwirft alle Gersten mit mehr als 11 % Protein als für Brauzwecke untauglich. Solche Gersten würden sich am besten für die Bereitung von Brennereimalz eignen. Haase schlug vor, daß eine gute Braugerste nicht mehr als 10 % Protein enthalten solle, später nahm er 11 % als die Grundlage seines Bonitierungssystems an. Dieser Standpunkt bezieht sich auf die zweizeilige Gerste, Hanna, Chevallier usw., welche in Europa gebaut wird. Er hat keine Anwendung auf die gewöhnlichen sechszeiligen Gersten der amerikanischen Mittelstaaten — Mandschurier und Oderbrucher — wie Wahl gezeigt hat. Der durchschnittliche Proteingehalt dieser Gersten liegt näher 12 als 11 %. Die Bay-Brewing-Gersten von Kalifornien und die sechszeilige Utah-Wintergerste enthalten im Durchschnitt 10.5 % Protein. In seinen früheren Veröffentlichungen hat Wahl gezeigt, daß mäßig proteinreiche Gersten, richtig gemälzt und verbraut, bessere Resultate ergeben können als proteinarme Gersten, weil die ersteren Malze liefern, die besonders reich an Diastase und Peptase sind. Die Malze aus solchen Gersten sind nicht allein imstande, mehr Stärke gehörig zu verzuckern, als sie selbst enthalten, sondern während des Mälzens und Maischens wird eine verhältnismäßig große Menge Protein durch die Peptase löslich gemacht, und die Biere aus solchen Malzen sind reicher an Stickstoffverbindungen als die aus eiweißarmen Gerstenmalzen bereiteten. H. T. Brown und seine Mitarbeiter haben gezeigt, daß nach neuntägigem Mälzen 35 % der stickstoffhaltigen Bestandteile des Mehlkörpers löslich und diffusibel geworden sind und dem Keimling zugeführt werden. Diese löslichen Proteine sind in dem Malze vorhanden und kommen in der Würze in geringen Mengen vor und üben nach der Anschauung gewisser Forscher einen verhältnismäßig großen Einfluß auf den Charakter des fertigen Produktes aus.

Nach Jalowetz sind die Körner in der oberen Hälfte der Aehre stickstoffreicher als diejenigen auf der unteren Hälfte, aber das Basalende des Kornes enthält mehr Protein als das äußere Ende, und der Proteingehalt kann in einzelnen Körnern derselben Varietät und von demselben Felde starke Schwankungen aufweisen. Schjerning hat die Stickstoffverbindungen der wachsenden Gerstenpflanze in drei verschiedenen Stadien der Entwicklung studiert und ist zu dem Schlusse gelangt, daß die Gerste ihre Vollreife erreicht hatte, wenn die größte Menge Kohlenhydrate und Proteine aus dem löslichen in den unlöslichen Zustand übergeführt war. Er zeigte, daß die chemische Zusammensetzung nicht von der Art der Varietät oder dem Typus der Gerste, sondern von der Beschaffenheit des Bodens, den klimatischen Verhältnissen, der Länge der Wachstumsperiode und der Behandlung auf dem Felde beeinflußt wird. Dies stimmt mit den Forschungen von Kukla, Jalowetz, Prior, Wahl und anderen überein.

Eingehendes Studium ist auf die Verschiedenheiten in dem Aussehen der Gerstenkörner verwendet worden, insofern einige einen mehligen Endosperm, andere einen glasigen und durchscheinenden aufweisen. Brown hat die Beobachtung gemacht, daß glasige Körner oft in mehlige verwandelt werden können durch künstliches Reifen, durch Weichen oder sogar durch Lufttreifen nach dem Schneiden. Johannsen zeigte, daß der Unterschied zwischen einer mehligen und einer glasigen Gerste von der größeren Anzahl der Lufträume in dem Mehlkörper der ersteren herrührt, und daß die Gersten in ihrem ursprünglichen Zustande keinerlei Zusammenhang zwischen dem Grade der Glasigkeit und dem Stickstoffgehalt aufweisen. Prior isolierte die verschiedenen Proteinarten und stellte deren Einfluß auf die Mürbigkeit der Gerste fest. Er fand, daß die Ursachen der scheinbaren Glasigkeit in den wasserlöslichen stickstofffreien und stickstoffhaltigen Bestandteilen des Mehlkörpers zu suchen sind, welche Bestandteile kolloidalen Charakter besitzen und die stärkehaltigen Zellen fest zusammenhalten. Wenn diese scheinbar glasigen Körner geweicht werden, so gehen die bindenden Teile in Lösung. Die wirkliche Glasigkeit rührt davon her, daß die stärkehaltigen Zellen durch das Hordein und das unlösliche Protein zusammengehalten werden.

Munroe und Beaven haben gefunden, daß die Verwendung von Phosphaten zur Düngung die Qualität der Gerste mehr verbessert als die Verwendung von Kali, Soda oder Magnesia, während Hofdünger den Ertrag vermehrt, aber die allgemeine Qualität verschlechtert. Weins Versuche deuteten an, daß Stickstoff und Phosphate die Proteinbildung förderten, und daß Kali den Ertrag und den Stärkegehalt beeinflußte. Ferner wies er nach, daß die Gerstenpflanze in ihren frühen Wachstumsstadien eine große Menge Pflanzennahrung erfordert. Nach Hubert hängt der Ertrag, sowie der Proteingehalt von den Witterungsverhältnissen zwischen der Blüte- und der Reifperiode ab, und kann die Anwendung von Düngemitteln die Witterungsverhältnisse nicht überwinden. Er legt auch Gewicht auf die Notwendigkeit, reine Gerstenrassen zu besitzen, welche nur mit Hilfe des Botanikers zu erzielen sind. Er zeigt ferner, daß reine Rassen gleichmäßiger wachsen und auf der Tenne gleichförmigere Resultate ergeben.

Windisch und Vogelsang zeigten, daß bei der Keimung und in der Maische der organische Phosphor der Gerste und des Malzes durch Hydrolyse in die anorganische Form übergeführt wird. Barnstein erörtert die Verdaulichkeit der Gerste und ihren Nährwert, sowie auch ihre anatomischen Merkmale. Er zeigt, daß die Kleberschicht zwei oder drei Zellen dick sein kann, eine Tatsache, die große Bedeutung bei der Betrachtung proteinreicher Gersten für Brauzwecke gewinnen kann, denn es ist erwiesen, daß diese Schicht während des Mälz- und des Maischprozesses so gut wie unverändert bleibt.

Weitere Studien über Gersten von physikalischen und botanischen Gesichtspunkten sind von Lloyd, Broili, Atterberg und Tedin und in Amerika von Nilson ausgeführt worden. Neuere Forschungen von Le Clerc und Breazeale haben den Nachweis erbracht, daß die Wurzeln der wachsenden Gerste nicht, wie Wilfarth, Römer und Wimmer angenommen hatten, Kali, Soda oder Stickstoff ausscheiden, sondern daß der Verlust an Pflanzennährstoffen dieser Art auf Regen und andere atmosphärische Einflüsse zurückzuführen ist.

Gerstenarten.

Die Gerste ist seit Tausenden von Jahren angebaut worden. Sie gedeiht in weit verschiedenen Klimas von Algier bis nach Island und wächst bei einer Höhe von über 10000 Fuß. Die in Amerika gebaute Gerste besteht zum größten Teil aus der sechszeiligen vom Mandschurier Typus, gemeinhin vierzeilig genannt. Die Mandschurier-Gerste und ähnliche Typen haben einen verhältnismäßig hohen Proteingehalt, meist über 11 %, die Körner

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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 304.

GROWING AND CURING HOPS.

BY

W. W. STOCKBERGER,

Expert, Drug-Plant Investigations, Bureau of Plant Industry.

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GOVERNMENT PRINTING OFFICE.
1907.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., June 14, 1907.

Sir: I have the honor to transmit herewith a paper entitled "Growing and Curing Hops," by Dr. W. W. Stockberger, which has been submitted by Dr. R. H. True, Physiologist in Charge of Drug-Plant Investigations, and I recommend that this paper be published as a Farmers' Bulletin to supersede "Hop Culture in California," issued as Farmers' Bulletin No. 115.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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GROWING AND CURING HOPS.

INTRODUCTION.

In keeping with the great progress made in agriculture within recent years the methods employed in hop production have not remained unchanged. Nevertheless certain practical principles of great importance to successful hop growing merit a much wider consideration and use than they now enjoy. These will be discussed in the following pages, in which is also presented a brief general outline of hop culture.

It is manifestly impossible to give a detailed account of methods of hop growing which would apply in all sections of the United States. The peculiar conditions of soil, climate, and location influence the prevailing methods of culture as well as the varieties grown and render it necessary for the practical grower to adopt those methods which, according to his experience, are best suited to his conditions.

CONDITIONS ESSENTIAL TO HOP GROWING.

CLIMATE.

The hop plant can be grown generally throughout the United States, but at present its commercial production is practically restricted to areas situated in the States of Oregon, California, New York, and Washington. Small quantities are raised in Wisconsin, Idaho, Massachusetts, Pennsylvania, Michigan, Vermont, Kentucky, and Ohio. The accompanying map (fig. 1) indicates the distribution of the hop-growing regions in the United States and shows graphically how the industry has become sharply localized in districts which furnish the most favorable conditions. Long and severe winters frequently kill out many of the plants, and continued damp or foggy weather is usually followed by severe attacks of lice or mold.

While from the map it appears that hops are grown under very different climatic conditions, they are produced most successfully in the milder regions, where abundant early rainfall is followed by warm

dry weather as the crop approaches maturity. The accompanying chart (fig. 2) shows the average monthly rainfall in the chief hop-raising sections of the United States. In the Yakima Valley, Washington, where the rainfall is very scanty, irrigation is necessary. The hop plant readily adapts itself to very different conditions of rainfall, but when the harvest months—August and September—are accompanied by much rainfall the crop frequently suffers heavy damage from lice and mold.

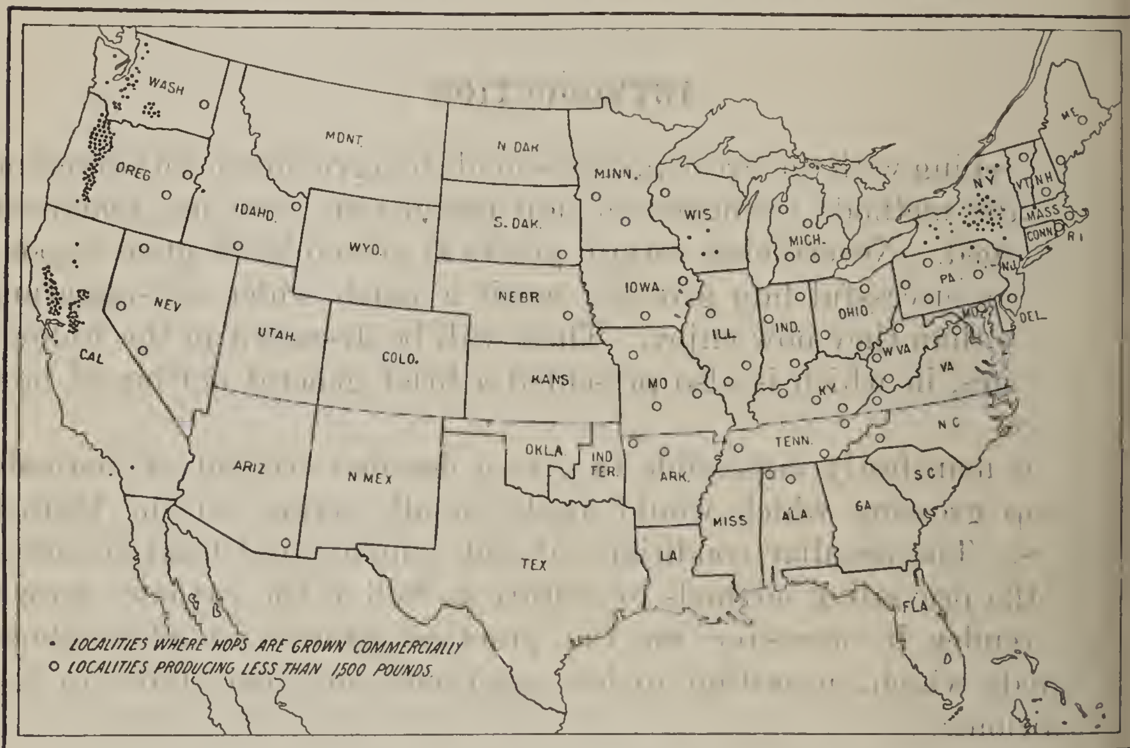


FIG. 1.—Map showing the hop-producing areas of the United States.

SOIL.

The selection of the best soil on which to grow the hop plant involves the consideration of several factors, depending on the peculiarities of the plant itself and the physical conditions of the region in which the land lies. In general, rich alluvial lands or deep sandy or gravelly loams are preferred for hop raising. The soil with a high percentage of sand is readilly tillable, while the cultivation of a stiff soil is difficult and expensive. Owing to variations in the rainfall, amount of sunshine, and force of the prevailing winds, land suitable for hop culture in one region would be entirely unsuitable if located in another. Since the roots of the hop plant penetrate the earth for a distance of many feet, a well-drained subsoil is essential. Especial attention must be given to the depth, fertility, drainage, and fineness of the soil. Heavy wet soils are avoided and stiff clayey soils are in general disfavor.

PROPAGATION.

PROPAGATION FROM SEED.

Hop plants may be raised from the seeds, but this method is seldom employed, since by using cuttings strong plants are more easily and quickly secured. Moreover, seedlings have a tendency to vary greatly, both as to the time of maturing the hops and the quality of the product. Yards planted with seedlings usually show little uniformity in the variety of hops produced and in the time of ripening. Seedlings will not produce hops the first year, and only a small yield may be expected the second year.

USE OF CUTTINGS.

The simplest method of growing hop vines is from root cuttings, also called "roots" or "sets." In some localities roots that have been in the nursery for one year are called "sets." The numerous

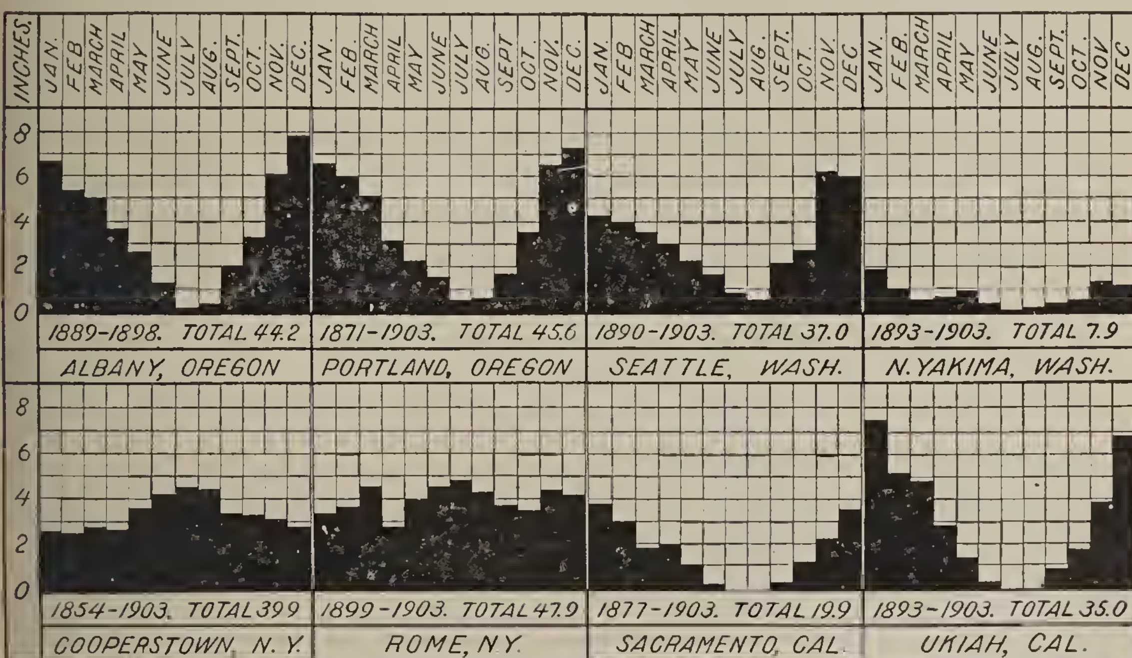


FIG. 2.—Chart showing rainfall in the principal hop-growing regions of the United States. The chart shows the average rainfall during each month in the year for the period of years indicated in the space below. The totals given are average totals for the years indicated.

surface runners sent out by the hop plant are removed when the plants are pruned in the spring, and these, cut into pieces each bearing at least two sets of "eyes" or buds, are used to produce new plants.

In some sections of the Pacific coast a crop may be obtained from cuttings planted in the spring, but in general a full crop is not harvested until the second year.

The best cuttings are those taken from young plants, as they are more resistant to disease and should be more productive than those from old plants. All cuttings should be carefully inspected before planting and the diseased or damaged ones rejected.

ORIGINATING NEW VARIETIES.

The important subject of originating new varieties, as well as the no less promising one of improving existing varieties, merits the attention of every hop grower. The plants of every field are more or less variable. Some bear more heavily than others, some are richer in the desirable resins, and some will show other high-grade qualities. New varieties may be sought for among the plants in the nursery when these are grown from seed. After the seedlings have been transplanted to the yards and have matured a crop a careful examination at picking time may show that some have superior qualities. These should be suitably marked and cuttings made therefrom the next season for further selection. There is no good reason why this method if persisted in should not produce valuable new varieties. The favorable results secured with new and improved varieties of corn, wheat, grapes, and other crops may be duplicated in hop culture and suggest lines along which improvement may be made, particularly in regard to bettering the quality of the product.

The opportunity for producing improved sorts by selection of the stocks from which cuttings are taken offers a promising field for the progressive hop grower. Many growers who give much attention to improving the fertility of their fields and their methods of cultivation take their cuttings for planting from the nearest available supply without any consideration of the productiveness and other qualities of the plants from which the cuttings are taken. This has resulted in many yards in the loss of certain distinct varietal characteristics, and in almost every field mixed varieties and light and heavy producers occur indiscriminately.

A decided improvement in quality should follow the careful selection of cuttings with reference to productiveness, uniformity, disease resistance, and general adaptability to the cultural conditions in the region where they are to be grown. The selection should be made at picking time, when the hills containing plants of superior quality and productiveness can be staked, so that cuttings may be taken therefrom the next season.

PLANTING AND CULTIVATING.

TIME TO PLANT.

The time at which planting is done depends very largely on the local conditions existing where the crop is grown, but in general the best results are obtained by planting as soon as the soil can be worked into a fine mellow condition. In California planting should be done in January or February, although in some seasons planting as late as the 1st of May has yielded good results. In Oregon and Washington hops are planted in March or April, and in New York successful plantings have been made in April in favorable seasons.

SETTING THE ROOTS.

In California practically all new hops are now set out in rows at a distance of 6½ to 7 feet apart each way. When set 6½ feet apart, there will be 1,031 hills to the acre and 42¼ square feet of soil to the plants of each hill; when set 7 feet apart, there will be 898 hills per acre and 49 square feet of soil to the plants of each hill. In Oregon and Washington, where two horses are used in cultivating, the distance between rows is usually 8 feet, requiring but 680 plants per acre.

The methods of cultivating the hop yards necessitate straight rows. Three and often four cuttings are set in each hill. Differences of opinion and practice exist, and the number which it is advisable to set is in a measure dependent on the system of training employed and the cost of roots. The setting of a fourth root is a measure of precaution against the possibility of loss by rotting or injury of one or more of the cuttings after they are set out.

A good method of setting the roots is first to mark the center of each hill by a small stake to which are attached the strings on which the vines are to run; then, about this stake to make three holes forming roughly the apices of an equilateral triangle with a side measuring about 6 inches. These holes are usually made with a dibble, but in very compact soils an iron crowbar is frequently used. The roots are then placed singly in these holes in an upright position, with the buds pointing upward, at such a depth that they will be from 1 inch (in Oregon) to 3 inches (in California) below the surface of the soil, which is then slightly tamped about them. Another method is to make a hole with a spade at the location of the hill and to plant therein from one to four roots, according to their strength. This is the more rapid method but is less desirable, since the roots are crowded together and are more subject to decay.

The price of roots is quite variable, ranging from $1 per 1,000 when they are plentiful to from $8 to $10 per 1,000 in years when they are scarce.

CULTIVATING.

Thorough cultivation is important and should begin early and continue until the plants are well armed out. This is necessary not only to keep down the weeds, but also to prevent the topsoil from forming a crust and becoming hard, for when it is in this state the moisture of the undersoil rises to the surface and evaporates quickly. The frequent stirring of the topsoil to a depth of 2 or 3 inches will produce a layer of finely divided soil which conserves the moisture near the surface, where it is more readily reached by the young feeding roots which develop at about the time the hops go into the burr. If these small feeding roots are destroyed or seriously injured by late cultivation, growth will be checked and early ripening favored.

Careful growers agree that the young buds do not set so well if the feeding roots are seriously disturbed, and that the crop is shorter in consequence. Nevertheless, if the soil is becoming hard and the moisture is readily evaporating, it may be best, at least in dry sections, to cultivate and depend upon a second growth of the feeding roots for the proper maturing of the crop. The existing soil conditions must determine the advisability of cultivating after the appearance of the feeding roots.

PRUNING.

By the process of pruning, the excess shoots from the rootstock are removed and the formation of fewer but at the same time stronger vines is favored. The rootstock itself also is reduced to an acceptable form and suitable depth below the surface of the soil, and the formation of undesirable runners is retarded or suppressed. The working over of the ground incident to pruning also is an important part of cultivation.

Within certain limits determined by local conditions, the length of the growing period and the time of ripening may be influenced by the earliness or lateness of pruning. The general practice is to prune early in the spring, the exact time being determined by the season and the locality.

A common practice is to draw four or five furrows with a small plow on each side of the row, turning the earth away from the hills. The yard is then cross-plowed in a similar manner, leaving each hill a small undisturbed square. The earth is then hoed and grubbed away from the roots, and the superfluous roots and runners, together with an inch or two of the top of the root crown, are cut off with a sharp knife. After pruning, the hoe is used to pull the soil back upon the hill, covering the rootstock to a depth of 2 or 3 inches. Too much pruning by this method causes disease, and frequently uneven pruning causes the late coming out of the overpruned vines.

Another method which offers several advantages over the former is to prepare the ground by plowing as before, using a coulter on the plow in drawing the last two furrows. The hill is not dug into, but instead a sharp spade is used, with which each side of the hill is cut down on a slant from top to bottom, leaving the hill about 4 inches square at the top and 12 to 14 inches square at the bottom. With this method baking of the soil over the hill is avoided and the new shoots come through much more easily. The pruning is more even and the rootstock suffers less from wounds and bruises than by the former method.

TRELLISES.

Except in the hop-growing regions of New York, the use of hop poles (fig. 3) has been largely discontinued in those regions where there is a scarcity of available timber, and even in heavily wooded sections many growers have dispensed with them. This is not due to the labor and expense of handling alone, but experience has proved that the advantages of growing hops on strings so far surpass the growth on poles that it is only a question of time when poles will be almost entirely abandoned. The hops are health-

FIG. 3.—A field of hops growing on poles.

ier on strings, more successfully sprayed, mature earlier, are usually richer and brighter, arm out lower, and are not so leafy; they do not wind-whip so readily, can be picked cleaner, and are much more easily torn down for picking. Also the hops can be picked without cutting the vine, a practice which is harmful, since it prevents the return of materials from the vine to the root of the hop, and, by causing a loss of food reserves to the stock, produces a weakening effect on the succeeding crop.

For a permanent yard some form of the wire trellis shown in fig. 4 will doubtless give the best satisfaction in most sections. In sections where timber is plentiful the first cost somewhat exceeds that of the pole system, but the saving in labor, the advantages afforded in spraying, and the heavier crop obtained by this method have uniformly reduced the cost of hop production where poles have been replaced by wire trellises.

The wire trellis is constructed in almost numberless ways, but these may all be included in two general classes or types—the high and

FIG. 4.—Roadway between fields of hops, showing a fine growth of vines on high wire trellises.

the low trellis. The high trellis is most widely used, and upon it the greatest improvements have been made.

THE HIGH TRELLIS.

The high-wire system consists essentially in setting posts at every sixth or seventh hill throughout the yard. Over the tops of these posts wires are stretched across the yard each way at right angles (fig. 5). Posts are also set at the ends of the intervening rows, between which wires are stretched over the rows. These wires are fastened to the cross wires, and strings led up to them from the hills support the vines.

For posts, which may be either split or sawed timber, suitable hard wood or creosoted pine is used. These posts are usually from 4 to 6 inches in diameter and 20 feet long. The end posts should not be less than 6 by 6 inches, but somewhat lighter timbers may be used for

interior supports. The posts are set from $1\frac{1}{2}$ to 2 feet in the ground, the interior ones upright, those in the outside rows inclining somewhat outward. At a distance of about 14 feet outward from the foot of each end post an anchor, made of a piece of timber 6 by 6 inches and 4 feet long, is buried at a depth of 4 to 6 feet, according to the tenacity of the soil. Anchors made from locust are preferred, because of the lasting quality of the wood. A strong guy wire is run from the top of the post and fastened securely to the anchor; or the string wire may be run over the top of the end post and down to the anchor.

To permit easier access to the field, posts are frequently placed at the ends of alternate rows only. The string wires of the rows without end posts are then either run over the end cross wire to the ground and anchored or they are forked and fastened to the end posts on

FIG. 5.—Field of hops, showing details of the drop-wire trellis and method of picking.

each side. For the principal or cross wires running across the field the shortest way and fastened on the top of each post with heavy staples, No. 0 annealed iron wire is used. These wires are keyed up taut and fastened securely to anchors at each end. For the other or string wires Nos. 6 to 8 annealed iron wires may be used. On the latest improved or drop-wire trellis shown in figure 5 the string wires are held in place underneath the cross wire by short S-hooks made of No. 2 wire. At picking time the string wires may be unhooked and let down, thus bringing the hops within easy reach of the pickers. This trellis can usually be erected at a cost of from $80 to $90 an acre, and twine for supporting the vines necessitates an annual expenditure of about $5 an acre.

In another successful form of this system an additional wire, known as the "breast wire," runs over each row below and parallel to the string wire at a height of about 6 feet from the ground. The strings rise vertically to the breast wire; then they are taken on the slope to the top or string wire, which is above the next row of hills. The angle of the sloping string is affected by the distance between the rows as well as by the height of the breast wire. The steeper the slope the better the growth of the vine. At half slope hand training will be necessary, but a flat slope gives better exposure to the sun and increases productiveness.

THE LOW TRELLIS.

The low form of trellis appears in several modifications. In one form poles about 8 feet long are set at each hill. Over the tops of the poles wires are run the full length of the yard each way, crossing at right angles. The vines are led up the poles or stakes and then find support on the wires. In many cases stout twine is used instead of wire, and in some instances the poles are set at every third hill.

Except in situations swept by strong winds, the high trellis is much more satisfactory. It is a permanent structure which gives easy access for teams to every part of the yard. The hops receive more uniform exposure to light and air and are in consequence better developed. Cultivation is not interfered with by drooping arms so much as in the low-trellis system. The hops can be readily sprayed even at picking time, when the worst attacks of lice are likely to occur. Since a hop vine will not follow a horizontal support, when it reaches the wire or string of the low trellis it must be trained by hand, thus materially increasing the cost of cultivation.

SYSTEMS OF TRAINING.

STRINGING.

Where the high-wire trellis is employed, cotton cord is used to form supports for the vines until they reach the wires. The string consists of two portions knotted together; one, a cord 4 feet long having a breaking strain of 80 pounds, is attached to the wire, and the other, a cord 15 feet long having a breaking strain of 20 pounds, is tied to a small stake set in the hill. The smaller cord is strong enough to support the vine until it reaches the heavier cord at the top. Good hemp is often used for the top string instead of cotton cord. The string may be fastened to the wires by means of a special knot-tying device attached to the end of a long pole, but the plan pursued in the trellis fields where the drop-wire system is used is simply to unhook and lower the string wire (fig. 5), to which the strings may then be attached by the workmen while standing on the ground. The strings, which are cut to the desired lengths and

knotted in advance, are fastened to the wires about 20 inches from a point on the wire directly over the center of each hill. Usually but two strings are used for each hill, and when all have been fastened to the wire it is again hooked up in place on the cross wires.

Another plan is to use a "trellis wagon," on which is a platform of such elevation that the workmen thereon may move about freely beneath the wires while attaching the strings. The wagon follows the string wire across the field. Two or three men on the wagon will put the strings on two wires as fast as the team can walk. Four men following the wagon can fasten the ends of the strings to small stakes set in the ground at each hill.

In the pole yards of New York a loop in one end of the string is passed over the top of the pole by means of a forked stick, and then drawn taut. The remaining end is then fastened to the adjacent pole in the next row about 5 feet from the ground. Frequently another string is fastened from pole to pole at the same distance above ground.

TRAINING.

When the young vines are about 2 feet long training is begun. Usually the four runners most closely approaching in length the average of the field are selected from each hill and the remainder are cut off. In case of an uneven stand it may be well to cut off the whole field and wait for the second set of runners. However, vines which may be inferior at first sometimes develop a vigorous growth after they have reached a length of 4 or 5 feet. As a general rule, in all light producing sections it is advisable to train the first runners; in heavy producing sections the second runners should be chosen. Two runners are usually trained to each string, care being taken to twine them from left to right about the string.

In the New York yards many farmers train seven vines up each pole, three for the long string and two each for the other string and the pole.

PICKING.

TIME TO PICK.

The time when hops should be picked varies with the locality, the season, and the variety cultivated. When the acreage is large there is a tendency to start picking before the crop is fully mature, as otherwise a portion may be lost through becoming overripe. Also a great consideration with many growers is the early securing of pickers. To this end it is customary in some sections to plant an early-bearing variety, e. g., Fuggles, which ripens from a week to ten days earlier than the other standard varieties and enables the grower to begin picking so much earlier.

A second consideration is the capacity of the drying plant to handle the crop as fast as harvested. If the acreage is large and the crop heavy, the facilities for handling and drying the hops will be taxed to their utmost, and if more hops are picked than can be put upon the kilns and dried without delay they undergo heating and are thereby seriously damaged in quality or lost entirely. Because of inadequate facilities, therefore, growers frequently begin picking before the hops are ripe and continue picking after they have passed what is recognized as the most suitable stage for harvesting.

A third consideration, which is recognized by all progressive growers, is the effect of the picking time upon the quality of the product. The development of the essential oil, the desirable soft resins, and other valuable constituents reaches its height about the time the hops become fully ripe, in which condition they are generally regarded as possessing the finest flavor.

From the standpoint of the consumer the time of picking is a matter of great interest, and it should be also to every grower, as a much higher quality of hops would result from picking at the proper time. However, for reasons previously mentioned it is often very difficult to secure pickers when the crop is just ripe. In addition to the difficulties just mentioned, the several parts of the field rarely ripen exactly together; often when a field is practically level slight variation in quality of soil or moisture content will result in unevenness in ripening, and while it is customary in picking to work around and through the field, choosing first the ripe portions, it is rarely possible to pick all of the crop at the most desirable degree of ripeness.

While growers recognize in a general way the importance of a proper picking time, the disadvantages arising from a disregard of this time are not appreciated by all. There are several important objections to improperly picked hops which reduce their market value.

DISADVANTAGES OF UNRIPE HOPS.

Unripe hops contain more water in proportion to their weight of dry substance than those which are ripe; consequently in drying the "conversion" is not so high; that is, the ratio of the dry hops to the weight of green hops put upon the kiln is smaller when the hops are unripe. Unripe hops are also more difficult to dry on the kiln, probably because of their higher water content and tendency to pack together as soon as wilted, and also they do not keep so well when stored. Since the lupulin in unripe hops has not reached its full development, there is an absolute loss of weight by picking in this condition. The aroma is not so well developed and the amount of resins is smaller in the unripe hop. Not only is there a loss of weight due to too early picking, but practically all of the desirable qualities upon which the value of the hop depends are also in large measure diminished.

TESTS FOR RIPE HOPS.

By means of certain practical tests the degrees of ripeness and suitability for picking of the hop may be readily determined. (1) The strobiles or cones, which are bright green in color in the vegetative state, change gradually to a bright yellowish green as they approach ripeness. This is not always an exact test, as the color is somewhat dependent upon the soil and some other factors. Some hops have a greenish color when they are ripe. Sometimes in fields infested by the wild morning-glory a yellowing of the cones may occur, which is not due to ripening, but rather indicates an unhealthy condition in the plants themselves. (2) Immature hops are soft and pliable and have no resiliency or elasticity. As they ripen, however, they become more and more elastic, and if slightly compressed between the fingers will, on being released, assume at once their original condition. (3) When hops have a crisp feeling and give forth a rustling sound when crushed in the hand they are regarded as ripe. (4) The so-called seeds of the hop are in reality fruits, the seed being covered by a closely adhering pericarp, which, when the hop is ripe, takes on a dark purple color. At this time also the seeds fill out and become hard. (5) The bracts at the point of the cone close as ripening progresses, and the cones themselves feel sticky or greasy. (6) Immature hops have little odor aside from the natural green or plant odor until they are near ripeness, when the characteristic lupulin odor becomes very marked. (7) As the hops approach maturity the upper foliage leaves change from light green to dark green, while those on the lower part of the plant turn yellowish and drop off.

CURING.

THE OBJECT OF CURING.

The primary object of curing hops is to reduce rapidly their moisture content to such a degree that they may be safely stored and their properties preserved. Hops must be dried soon after their removal from the vines, as otherwise they undergo a process of oxidation or heating which seriously injures their appearance as well as their aroma and other valuable qualities. According to the variety and the degree of ripeness when gathered, freshly picked hops contain 65 to 75 per cent of moisture, but when in a dry state fit for storage or marketing they should contain only from 10 to 14 per cent of moisture. Increased knowledge of the constituents and properties of hops has extended the idea of curing to include the production of a hop which not only has a fine physical appearance, but which also contains the maximum amount of the desirable principles upon which its intrinsic value is based. The most important of these principles are the tannin, found mostly in the bracts of the cone, the soft resins,

the volatile oil, and the bitter principles which occur chiefly in the lupulin. Curing is all too frequently conducted with regard to the physical appearance alone, and the methods employed often injure the quality of the hop through their harmful effects on the oil, lupulin, etc.

THE THEORY OF DRYING.

The removal of moisture from hops constitutes drying. In the atmosphere this is ordinarily accomplished by evaporation, a process which is dependent upon the ability of the air surrounding the drying hops to carry off the surface moisture in a vaporized state. The amount of moisture in the form of vapor which the air can take up depends upon its dryness, since there is a maximum amount of vapor which the air can contain. When this maximum is reached the air is saturated or at the dew point and will take up no more moisture. In order that drying may proceed the saturated air must be constantly replaced by drier air, and a brisk artificial circulation therefore hastens the process.

The ability of the air to take up moisture varies with its temperature, and an immediate effect of heat on the atmosphere is to increase its capacity to absorb aqueous vapor; for example, it has been determined that the moisture in 10,000 cubic feet of air saturated with aqueous vapor at 62° F. weighs 8.81 pounds. On raising the temperature of the air to 82° F. the 10,000 cubic feet of air can take up 7.86 pounds additional moisture; and by increasing the temperature to 122° F. 42.61 pounds additional can be carried. If, however, the air at 62° F. is only half saturated, 10.000 cubic feet will contain but 4.4 pounds of moisture; then raising the temperature to 82° F. will enable the 10.000 cubic feet to take up 12.27 pounds additional, and increasing the temperature to 122° F. admits of 47 pounds additional being carried.

The volume of air necessary to effect drying within a given time is dependent upon its temperature. Because of its greater moisture-carrying power a small volume of air at a high temperature will absorb and carry away an amount of vapor the removal of which would require a relatively large volume of air at a low temperature. If half-saturated air heated to 162° F. in passing over a moist surface at the rate of 10,000 cubic feet per minute removed therefrom in that time 130 pounds of moisture, it would require about twenty-three minutes to carry away 3,000 pounds of moisture. If, now, the same air were cooled to 82° F., 10,000 cubic feet per minute could remove about 12 pounds, and nearly four and one-half hours would be required to remove 3,000 pounds of moisture. To carry away the moisture in the same time as the air at 162° F. a volume of about 108,000 cubic feet per minute would be required.

In practice it has been found that the air driven through a mass of hops does not become fully saturated with moisture, and only during the early stages of drying does the amount of moisture actually removed approach the quantity which would be removed if the air carried its full capacity. At the temperature commonly used in drying, therefore, a much larger volume of air must be provided to remove a given amount of moisture than apparently would be required from a consideration of the figures given.

A certain degree of heat is always advantageous in drying hops because of the conditions under which the moisture in them occurs. A part of this moisture is free water and is the first to be exhausted in drying. The rest forms a part of the sap and tissues, and its removal affects the physical condition of the drying hops. Heat, by raising the temperature of the tissues and cell sap, promotes the passage of water to the surface, where it may be removed by vaporization. An artificial supply of heat is also necessary to replace that lost from the hops by the process of vaporization; otherwise the temperature of the moisture held in the cells will remain so low that it will not move readily to the surface and drying will be retarded.

In drying hops good results, however, are not obtained merely by supplying a high degree of heat below the floor of the kiln. When hops are piled on the floor at a depth of from 14 to 30 inches, they form an extremely poor conductor of heat. Not only are the hops themselves a poor conductor, but the air heavy with aqueous vapor filling the spaces between the hops offers much resistance to the transfer of heat. It thus happens that when heat is applied to the floor of hops the moisture of the lower layers is driven off, the air in contact with them becomes saturated, and, rising quickly, comes into contact with cooler layers. Here the saturated air is cooled, with the result that its moisture is condensed and deposited on the upper layers of hops until they become wet and soaked. The continuous application of heat thus results in the lower layers becoming dried out and overheated, while the heat gradually working upward through the wet layers of hops subjects them to a harmful steaming process. The difficulty is frequently increased by the practice of turning the hops, as in this way the overdried layers from the bottom are brought to the surface and again steamed and dried.

It is evident that a rapid and continuous removal of moisture is desirable, and to accomplish this draft and ventilation are necessary. A strong draft is necessary to insure a rapid movement of the heated air through the layers of hops, since by rapid replacement of the air in contact with the moist hops time is not afforded to approximate the point of saturation; hence the air can undergo quite a degree of cooling in the upper layers without reaching the dew point and depos-

iting its moisture. Top ventilation is necessary to remove the vapor-laden atmosphere from above the hops; otherwise the point of saturation would be quickly reached and the moisture deposited on the sides of the kiln and the hops themselves. Ventilation is closely connected with draft and is dependent upon it. Conditions which secure good natural draft usually provide sufficient ventilation.

Draft and ventilation, as well as drying itself, are very dependent on the temperature and humidity of the atmosphere. Draft or a definite upward movement of the air in a kiln occurs when heat is applied at its base. The cold air outside the kiln being heavier than the warm air within constantly tends to establish an equilibrium of pressure by flowing down to the base of the heated kiln. As a direct consequence the heated air is forced upward, and the cold air taking its place is in turn heated and will follow the same course. A continuous circulation is thus established, its velocity and volume depending on the difference in density of the outside air and the air within the kiln.

The changes of temperature in the external atmosphere have very marked influence on draft. In hop drying it is observed that the best draft is usually secured about 2 or 3 o'clock in the morning. This is about the time when the greatest temperature differences exist between the outside and inside air, with a corresponding difference in pressure resulting in increased draft. This advantage, however, is largely offset by the great increase of humidity in the atmosphere at night. In the daytime when the air temperature is high great difficulty frequently arises in securing a draft without at the same time overheating the hops. Usually a difference of about 50° F. between the temperature under the kiln floor and that over the top of the kiln is necessary in California to cause a sufficient pressure to force the air through the hops. In Oregon a difference of 30° F. is generally sufficient to accomplish the same result, the reason for the difference being that the hops are not laid so deep on the floor and twenty to twenty-four hours are used in drying as against ten to twelve hours in some districts in California. Assuming that a difference in temperature between the atmosphere and the air in the kiln of from 30° to 50° F. is necessary to cause a draft through the hops, it is apparent that the greatest care must be used to avoid damage to the hops through overheating.

Many of the difficulties attendant on the use of natural draft have been overcome by recourse to forced draft. By this means a large volume of air is driven through the hops, instantly setting up a good circulation of air and rapidly carrying off the moisture, so that the hops do not undergo the long sweating and steaming process which is a necessary accompaniment of the use of a natural draft. Drying

is possible also at a much lower temperature, and this method presents many other advantages, among which is absolute control of a low, even temperature, giving an increase of soft resins, flavor, aroma, and weight.

NATURE OF THE CURING PROCESS.

When the hops are placed upon the floor of the kiln the cells which compose their tissues are still alive. Proper curing consists in bringing about the death of these cells through the gradual withdrawal of water from them at a moderate temperature. Within each cell are many chemical substances which remain separated so long as the cell is alive, but which are thrown out of solution by the loss of water from the cell and left in a form in which they are very readily soluble. If the removal of water does not proceed steadily, or if the vapors are allowed to settle back, moisture condenses on the hops and is readily reabsorbed and, coming in contact with the readily soluble substances, dissolves them. In this condition these substances cause blackening or discoloration and the hops are injured in other ways.

Death of the cells may be caused without much water loss by sudden exposure to high temperature. In such a case the chemical substances no longer remain separated, but flow together and form new compounds with resultant changes in color, aroma, and other desirable qualities. The cells may sustain a considerable water loss before they are killed, provided the temperature is kept below a certain point (about 110° F.). As soon as the death of the cell occurs and the flowing together of its compounds begins, drying should be forced somewhat more rapidly, in order to reduce the amount of water present as fast as possible, but even in this stage of drying the temperature can probably not long exceed 140° F. without injury to the quality.

PRACTICAL DRYING.

The most important and at the same time the most difficult part of hop production is proper drying. No other factor affects the quality, appearance, and market value as much as the manner in which the hops are handled during the curing process.

In the drying process three factors are of primary importance. These are (1) degree of temperature used; (2) length of time of drying; (3) volume of air passing through the hops. Also, in drying at a very low temperature the humidity of the air is an important factor. Only the first two of the factors mentioned have been generally recognized, and the high temperatures used at present are the result of shortening the time of drying. It is possible to diminish the temperature materially without lengthening the time of drying by forcing through the hops a large volume of air at low temperature.

The first care is to properly lay the hops on the drying floor. They should be spread out evenly and loosely to a depth of 14 to 24 inches, depending upon the ripeness. In an uneven floor the heat will break through first in the thinner places, which quickly become dry, while the thicker portions remain damp. If the hops are trampled or otherwise packed together on the floor the heat will not readily pass through them and drying is rendered uneven. Some practical growers set a stout wire screen of about 5-inch mesh at the desired height above the floor and the hops emptied from the bags upon this fall lightly and evenly to the floor beneath. The top is then carefully leveled with a rake.

As soon as the floor is laid the fires are started and the heat is gradually brought up to the desired point. In from three to five hours the hops will have become heated throughout and sufficient moisture will be driven off so that the hot air will readily pass through them. Until this point is reached the temperature must be closely watched, as too rapid firing at first will cause the under layers to scorch. In sections where drying is accomplished in ten to twelve hours a very common practice is to turn the hops with a wooden barley fork when the lower layers are dry enough to rattle when stirred. This should be done only when absolutely necessary, as turning breaks and shatters the hops and a portion of the lupulin is lost. Since the hops can not be turned evenly this practice hinders uniform drying.

During the course of drying sufficient ventilation must be provided to carry off the moisture without at the same time cooling the sides of the kiln and the top of the hops enough to cause the moisture to be deposited. Warming the air and the sides of the kiln above the hops materially aids drying. In the more northerly hop regions the most successful kilns are ceiled to the top, thus better retaining the heat.

The almost universal failure to recognize the harmful effects of high temperature in drying has caused wide diversity in practice. Temperatures of over 200° F. are not uncommon. That this is far too high has been shown by experiments made in the field with hops cured on various kilns at different temperatures. Aside from ruining the flavor by overdrying or scorching, there is a distinct loss of valuable essential principles by drying at high temperatures. The volatile oil, to which the aroma is largely due, is partially evaporated and the lupulin is rendered inferior, since the amount of the desirable soft resins becomes proportionately less as the drying temperature is increased. The best temperature for drying is yet to be determined, but every consideration indicates that it should be much lower than that commonly employed, probably between 100° and 140° F. Prac-

tical experience has shown that good drying may be accomplished with a temperature of 110° F., and the general trend of opinion is toward the use of the lower temperatures in drying. No fixed temperature, however, can be assigned as the most suitable for drying, because a degree of heat which at one stage of drying would probably be detrimental, at another would have no injurious effects. In taking the temperature care should be used to see that the thermometer is placed where the heat on the hops is greatest. This point has been found to be just below the drying floor. During the first part of the drying a thermometer below the cloth of the drying floor will register higher than one placed on the floor at the bottom of the hops, and one placed just above the hops will register 30° to 40° lower until drying is perhaps half finished or until the heat breaks through the hops. During this period of drying the heat is concentrated on the lower layers of hops, and here the greatest care is necessary to avoid injury. When the heat begins to break through the hops the upper thermometer will show a rapid rise of temperature, while the one below the floor will show a decline. From this point on to the end of the drying the two thermometers will show approximately the same degree of temperature.

As already stated, hops are frequently cured in from ten to twelve hours, but, other conditions being equal, a higher temperature must be used than when the time is extended to eighteen or twenty hours. The advantages of slower curing or curing at a lower temperature should be universally understood by hop growers. Even a moderately high temperature continued too long will damage the quality of the hops, the same as too high a temperature. In order that the hops may be dried at as low a temperature as can be made to do the work a strong draft is necessary during the drying to continuously carry off the moisture from the hops. There is no doubt that the principle of the air-blast kiln at present most satisfactorily meets these requirements.

No definite rule has yet been given for determining when hops are sufficiently dried. The condition in which they may be safely removed from the kilns can at present be told only by experience. The amount of drying will vary from day to day, being dependent upon weather conditions and the ripeness of the hops. In general, drying should continue until nearly all the stems or cores are shriveled, but are still soft and pliable. If overdried, the stems crumble and break readily, and the lupulin loses its bright, clear yellow appearance and turns brown. If hops are taken off the kilns slack or underdried they are very apt to heat, which turns the lupulin brown, and to develop a sour musty smell which makes them undesirable. If they are high dried or overdried they will

break badly and become chaffy, and they also develop a burnt, peanutty odor.

The thin leaflike portions of the hop usually become dry enough to break readily by the time the stems are dried sufficiently to make safe the removal of the hops from the kiln. This condition may be remedied by closing the ventilators half an hour before the drying is finished. This will also somewhat restore hops that have been overdried, as the further escape of moisture from the kilns is prevented, which then tends to equalize in the hops, soon softening and toughening them. Many careful dryers make a regular practice of gradually closing the ventilators as drying proceeds, and finish the kiln with them tightly closed. The same result may be indifferently accomplished by opening all the doors of the kiln and letting the hops cool for about an hour, as by this process they absorb moisture from the air and become less brittle.

SULPHURING.

The practice of sulphuring hops, which is now almost universal, is a response to the demands of the market chiefly for the pale yellowish green grades. The use of sulphur not only gives the hops the desirable yellow color, but makes them more uniform in appearance, thus increasing their salability. Many dealers are guided more by color than by other qualities, and such dealers have been known to rate unsulphured hops as inferior, while sulphured hops from the same field were classed as choice.

The use of sulphur improves the color by bleaching, injures the micro-organisms present, thus probably improving the keeping quality, and, according to a widespread belief, accelerates the drying. The sulphur is usually burned beneath the kiln floor at the commencement of drying. The usual practice is to use from 2 to 6 pounds of sulphur for each 100 pounds of undried hops. The action of the sulphur is most energetic while the hops are yet fresh and damp. Only refined sulphur of guaranteed purity should be used, as the crude sort usually contains impurities which may injure the quality of the hops. The best results are secured with what is known commercially as rock sulphur. Roll sulphur differs from this only in the form in which it is cast and has no greater bleaching power.

TYPES OF KILNS.

With respect to construction, there are many kinds of kilns. Whatever kind of structure is used for drying hops certain features are essential, and these may be comprehended in the description of a typical kiln. As regards methods of operation in the United States two general types must be recognized. In the stove kiln the hops

are heated by a stove or furnace placed under the floor; in the air-blast kiln a current of heated air from the outside is forced in by a fan.

The Stove Kiln.

This type of hop drier consists essentially of a furnace room heated by a large stove or furnace and a drying room immediately overhead, into which the heated air from the furnace passes through cracks in the floor. The stove may be situated in the center of the furnace room, but is commonly placed at one side and so arranged that the firing can be done from the outside. A very successful type of kiln is shown in figures 6, 7, 8, and 9. This combines the features of the simple furnace room with those of a style of kiln used on the Pacific coast and known as the "double-hopper" kiln. The building is a well-sided frame 36 feet square and measures 32 feet to the plate, from which the four-sided roof is carried up at one-half or two-thirds pitch. At the top an opening 8 feet square is left, over which is built the ventilator or cupola to a height of 12 feet. Two, or sometimes four, shutters, hinged to the sides of the cupola at the top, are fitted with ropes and pulleys, by means of which they may be opened and closed. Six feet below the plate, or 26 feet from the ground, are placed the joists which support the drying floor, which is composed of slats 1 to 2 inches wide carefully spaced at the thickness of one slat apart (fig. 7). Over the slats is

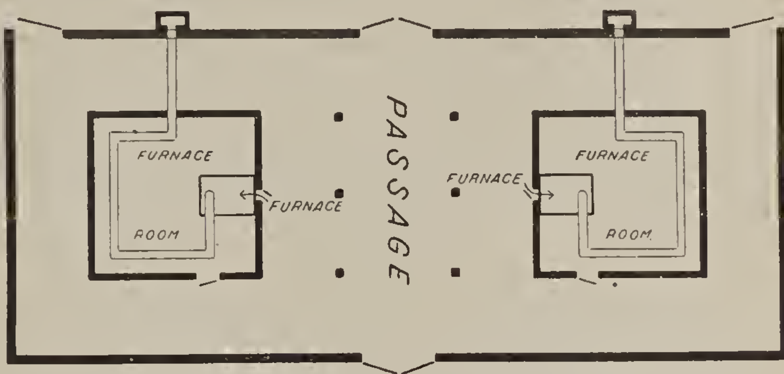


FIG. 6.—Ground-floor plan of stove kiln.

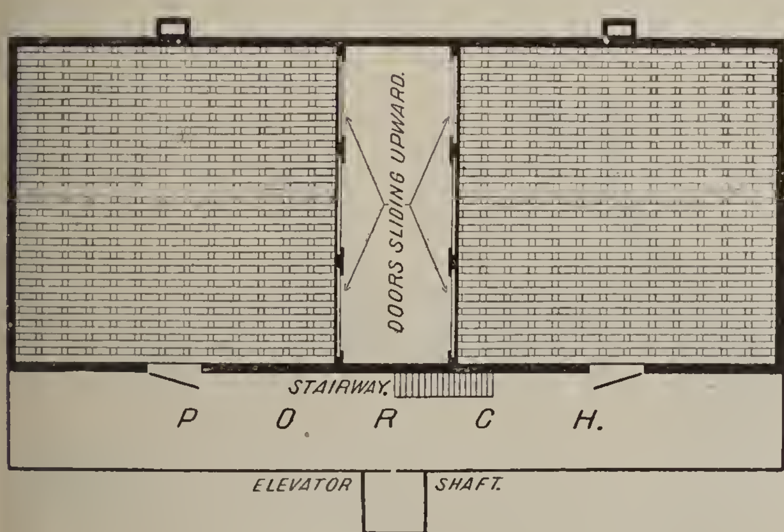


FIG. 7.—Plan of second or drying floor of stove kiln.

stretched a kiln cloth or carpet of 8 to 10 ounce jute, similar in quality to the ordinary barley sack. From the drying floor to the plate the inner wall of the kiln is ceiled in order to retain the heat. In humid regions the best results are secured when the ceiling is carried up on the rafters nearly to the top of the roof. In the center of the room below the drying floor is a second inclosure 18 feet square, made of 2 by 4 inch studding, 10 feet high, and lathed and plastered on the outside to within 10 inches of the floor, leaving next the ground an open space for the admission of air. The draft is largely controlled by means of large doors opening to the outside from the main room. In the type of kiln without the hopper air is admitted through openings in the outside walls close to the ground. These draft openings are provided with shutters which in case of a strong wind are closed on the windward side to prevent uneven drying.

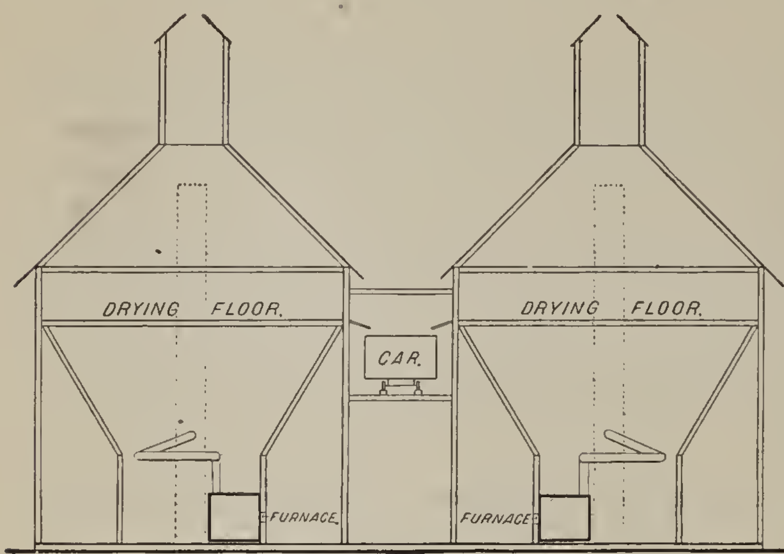


Fig. 8.—Sectional elevation of stove kiln.

From the top of the studding used in making the wall of the inner inclosure, timbers run on a slant to the outside walls, which they join just below the drying floor. These timbers are likewise lathed and plastered, forming as it were a huge hopper below the drying floor (fig. 8). The furnace is set in one side of this inner room, and the large pipe therefrom makes a circuit of the hopper at about 10 feet from the ground and is then led to the

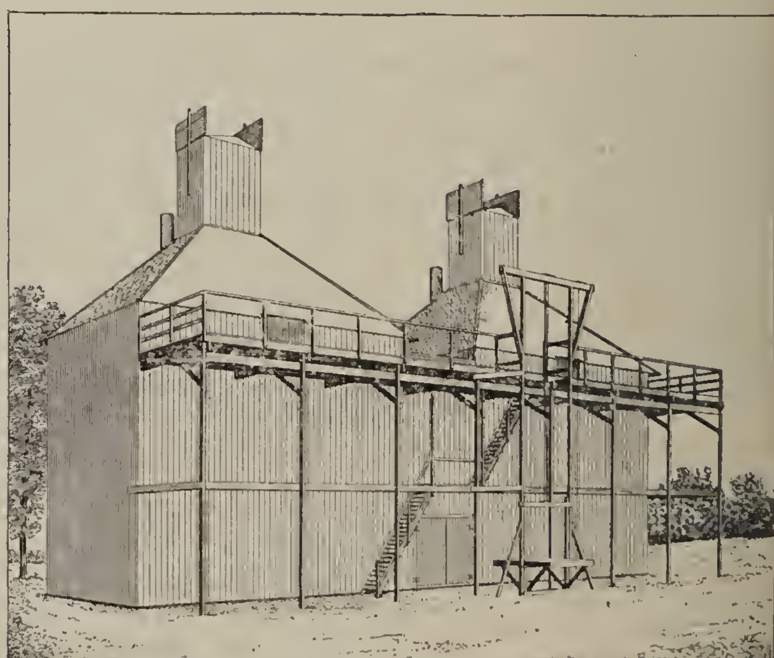


Fig. 9.—Perspective of stove kiln the plans of which are shown in figures 6, 7, and 8.

chimney outside. This kiln may be single or double, as shown in figures 6, 7, and 8. The size may be reduced to suit the needs of the user, and brick or stone may sometimes be used with advantage in its construction. The drying floor, however, should never be less than 20 feet above the ground, on account of the danger of scorching the hops.

The superior advantages claimed for this kiln are the even distribution of the heated air to the drying floor, the strong draft induced by causing all the air to pass in through the small furnace room where it is highly heated, and in the distance of the drying floor from the furnace, whereby the danger of scorching the hops by direct radiation is largely diminished. In this kiln, also, the objections to the real hopper form are largely overcome, since the lower portion of the woodwork does not come so close to the stove as to be in danger of catching fire.

On a level with the drying floor at one side of the kiln a platform is constructed, from which the green hops are transferred to the drying floor. When possible the kiln is erected on sloping ground, so that the hops may be unloaded thereon from wagons, which approach the kiln on a driveway formed by a slight embankment. Inclined wooden driveways, as shown in figure 14, are sometimes used, but the more common practice is to bring the hops from wagons on the ground to the platform by means of an elevator (fig. 9).

At one side of the drying floor doors sliding vertically permit the hops to be readily shoved off into the hop car, which is brought alongside the kiln with its top just below the level of the floor (fig. 8).

The "double-hopper" kiln has failed to realize the advantages hoped for on its introduction some years ago. It is not only very liable to destruction by fire, but the lower hopper limits too much the air space below the hops and does not give the necessary draft at the temperatures most suitable for curing.

The Air-blast Kiln.

The desirability of maintaining a strong draft through the hops while drying on the kiln has led to the employment of various artificial means for this purpose. A device for producing a forced draft which has long been used in England, and frequently tried in the United States, but with poor success, is an exhaust fan placed in the ventilating shaft of the kiln. In an improved method of drying with a forced draft which has been used successfully on the Pacific coast during the last few years a blast fan is used to drive the air through the hops from below. The main features of this method are illustrated in the air-blast kilns of the Pacific coast shown in figures 10, 11, 12, and 13.

These kilns, constructed of wood, of corrugated iron, or of concrete blocks, are from 30 to 36 feet square, and for economy and convenience three or more are usually operated in series under a single roof (fig. 13). Two drying floors are provided in each kiln (fig. 12), the first 9 feet from the ground and the second 7 feet above the first. The lower floors are generally made of slats and covered with a kiln cloth in the usual manner (fig. 11), but the upper floor is made of removable wire-covered sections. The distance from the ground to the plate is 18 feet and to the comb of the roof 30 feet. A low ventilator, fitted with shutters at the sides, terminates the roof and runs the entire length of the building. The draft in these kilns is produced by a blast fan from 7 to 9 feet in diameter, driven by a steam engine at a rate of speed high enough to produce a slight pressure in the air-tight room below the hops. As soon as the fan is started the pressure is established and the air quickly passes through the hops and escapes at the ventilators in the roof.

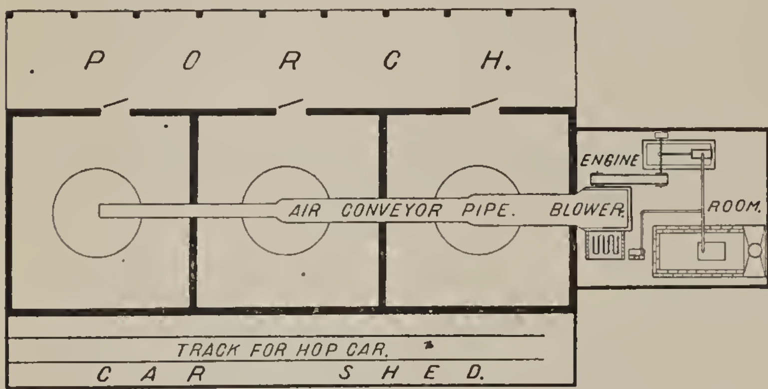


FIG. 10.—First-floor plan of air-blast kiln.

The air intake is outside the kiln, and just before the air enters the fan it is drawn through a sectional steam heater, constructed of 1-inch iron pipes, whereby its temperature may be maintained constant at any desired point. A large pipe, about 5 feet in diameter, conveys the air into the kilns (figs. 10 and 12). At the center of each kiln the air is delivered downward through a curved outlet of the main pipe, 34 inches in diameter, and fitted with a damper by means of which the amount of air admitted to the individual kiln is controlled. Below each outlet pipe is a saucer-shaped concrete-lined depression in the kiln floor which, receiving the inrushing air, deflects and distributes it evenly to the drying hops above.

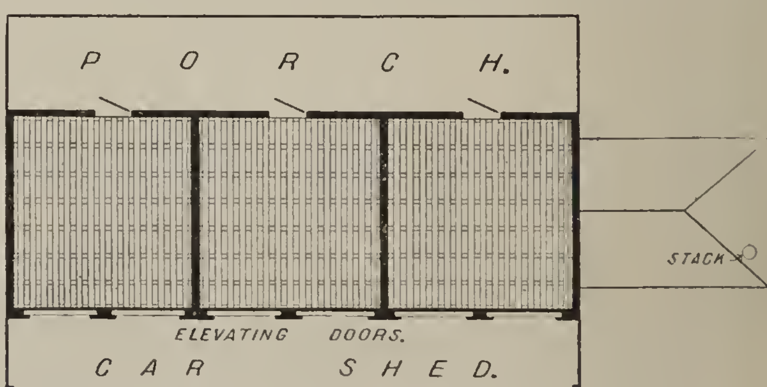


FIG. 11.—Plan of second or drying floor of air-blast kiln.

In a kiln 36 by 36 feet, when the hops are laid 15 inches deep, the green weight is estimated at 7,500 pounds. The conversion of the hops—that is, the number of pounds when green required to produce 1 pound when dry—varies from $3\frac{1}{2}$ to 4. This means, therefore, that in drying a floor of hops of the dimensions just given, from 5,000 to 5,500 pounds of moisture must be carried off. To accomplish this speedily a very large volume of air is necessary if the temperature is kept below the point where the quality of the hops is affected. The superiority of this type of kiln when equipped with a blast fan of sufficient size lies in the possibility of driving through the hops a large volume of air at a low temperature, thus carrying away the moisture and perfectly drying the hops, while overheating, overdrying, and scorching are avoided.

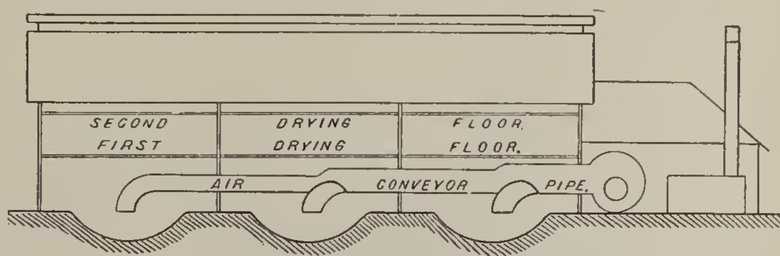


FIG. 12.—Sectional elevation of air-blast kiln.

The ordinary stove kiln may be readily converted into an air-blast kiln by the installation of blowers and devices for heating the air. Figure 14 shows a group of six stove kilns so modified at an expense much less than that necessary for the construction of an entirely new plant.

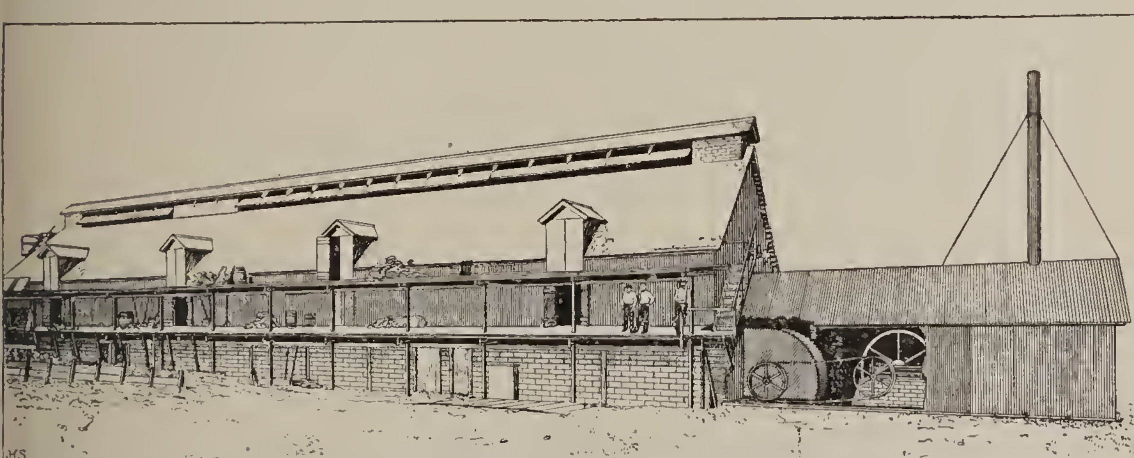


FIG. 13.—Perspective of air-blast kiln the plans of which are shown in figures 10, 11, and 12.

TREATMENT IN THE COOLER.

A very important part of the successful curing of hops is the handling which they receive in the cooling or storage room. The building used for this purpose (fig. 15) is now generally detached from the drying kiln and placed at a distance of 100 to 200 feet as a safeguard against fire. Figure 16 shows a sectional elevation of a cooling house with the two storage floors above the baling floor.

If necessary the lower floor may also be used for storage, but this necessitates elevating the hops to the second floor for baling. The building should be of tight construction, especially in humid regions,

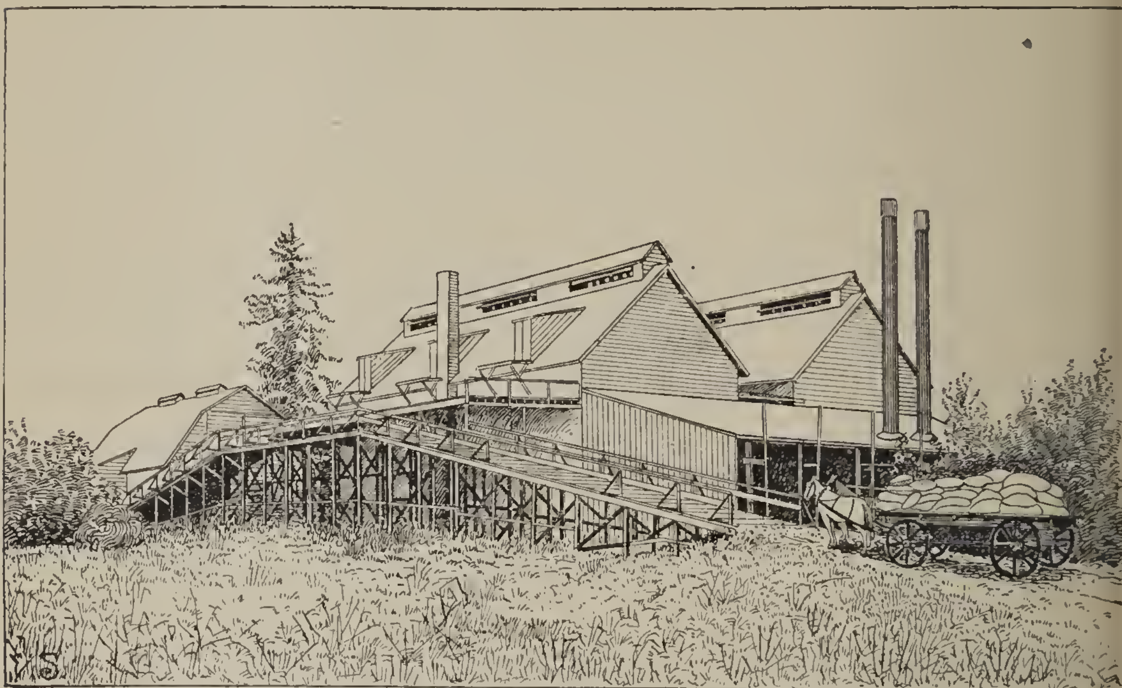


FIG. 14.—Group of six stove kilns converted into an air-blast plant.

to prevent the loose hops from absorbing too much moisture from the air.

The kiln is connected with the cooler by an elevated tramway,

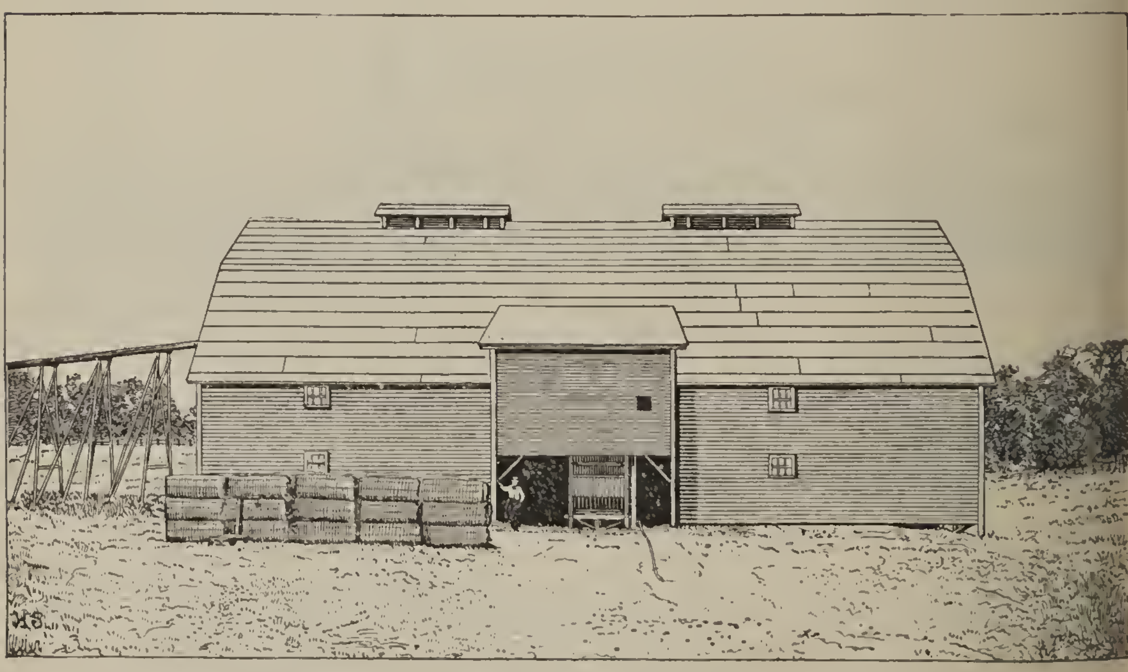


FIG. 15.—Elevation of cooling house, showing position of baling press.

over which is run a large car carrying the freshly dried hops. The sides of the car are hinged so as to swing open from the sloping bottom, allowing the hops to be readily removed with little handling.

The hops are spread out on the floor of the cooler, where they lose their heat and absorb some moisture from the air. The stems are usually not so dry as the other parts of the hop, and during the sweating process the moisture is equalized and the hops become tough and pliable. The best-informed growers recognize that other important changes occur during the sweating process which materially affect the quality of the product. A finer and more pleasing aroma, as well as a better physical appearance, is developed during sweating, provided the process is carefully watched and the hops prevented from becoming too moist or heated. Under ordinary circumstances these two evils are avoided by loosening up the hops and turning them over with forks or by moving them to another part of the cooler. If taken in time, slack hops may be brought out in this way and practically freed from their sour, musty smell. If the hops in the cooler

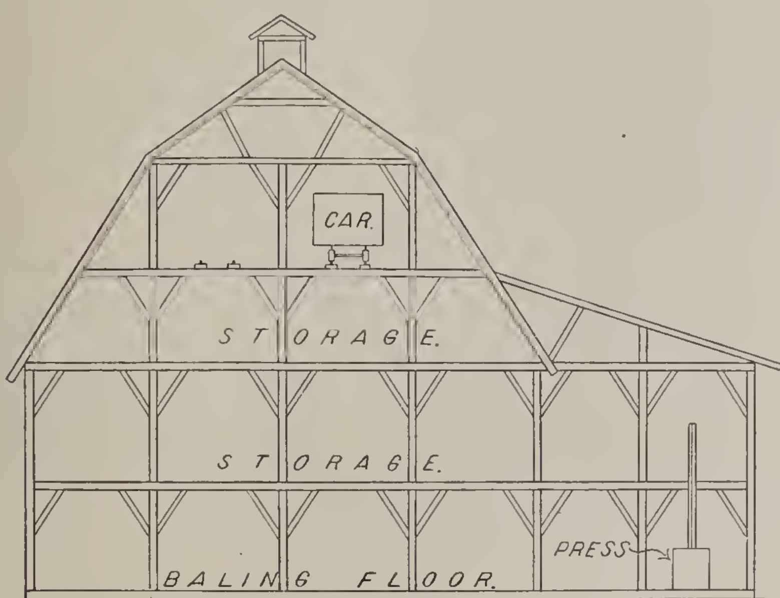


FIG. 16.—Sectional elevation of cooling house.

become too moist, their condition may be improved by dumping over them a car full of hot dry hops just from the kiln. Likewise hops that have become too dry in the cooler may be helped by mixing with them hops taken from the kiln a little before they are properly dry. Great care and good judgment are necessary for proper handling in the cooler, and more attention given to this phase of hop curing will certainly result in an improved quality of product.

BALING.

After the hops have been in the cooler for a week or ten days they will have passed through a sweating process and be in good condition to bale. Hops may be left in bulk for many weeks and suffer little injury if the storehouse is tightly closed to exclude atmospheric moisture. When suitable for baling, hops contain just enough mois-

ture to make them pliable and to prevent their breaking when compressed. If too much moisture is present in the bale, the hops will soon heat and turn black, being damaged thereby both in color and aroma, or they may be ruined entirely.

For pressing the hops into bales several styles of hop baler are used. In some sections where only a small crop is produced a hand-lever press is used. The form of this style of press, shown in figure 17, produces a bale measuring 24 by 18 by 63 inches.

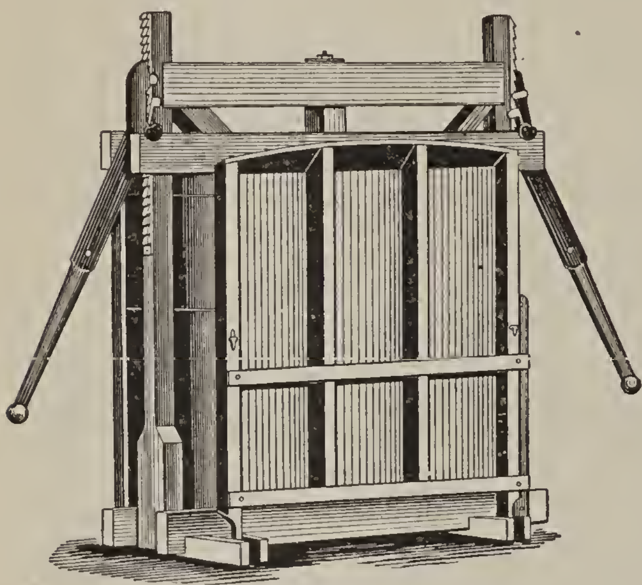


FIG. 17.—A baling press operated by hand.

For handling large crops some form of power press is always employed. A modern press which is easily operated with one horse is shown in figure 18. This is a vertical machine 10 feet 4 inches high and 30 inches wide. The doors swing upward to open and when closed are locked by a bar lock that fits a lug at each end of the press. The end gates are loose and may be easily removed when the doors are open. The follower is made of 4 by 4 inch timber and $1\frac{1}{4}$-inch boards, with a 1 by 6 inch steel bar across the top, to the ends of which twin cables are attached, by means of which the follower is brought down. The cables wind on a winch made with a 26-inch sheave and a 6-inch drum, using a sweep 12 feet long. Since the cable is wound first on the 26-inch sheave and then feeds onto the 6-inch drum, the downward motion of the follower is rapid at first, but becomes very slow as the volume of hops reaches the proper size for the bale. In this press the box is refilled and the follower brought down the second time for each bale. The bale produced usually measures 19 by 26 by 53 inches.

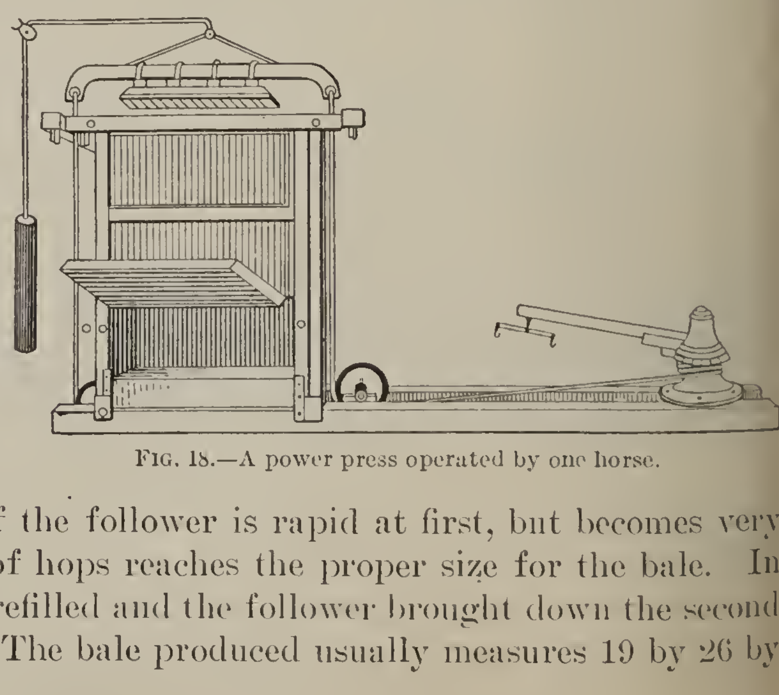


FIG. 18.—A power press operated by one horse.

The so-called Sacramento or "bull wheel" press (fig. 19) requires two horses for its operation. The box of the press measures 20 by 52 inches and is 8 to 10 feet high. Below the box is a 3-inch steel shaft, on one end of which is fastened a power wheel from 10 to 12 feet in diameter. On the shaft are two 8-inch pinions which mesh into cog racks 4 inches wide bolted to two 4 by 4 inch 16-foot scantlings which work up and down. These scantlings are connected at the top by a 4 by 12 inch crosspiece 7 feet long. From the crosspiece drop two 4 by 4 inch pieces from 8 to 10 feet long, to the free ends of which is attached the follower, which fits into the box and, when the power is applied by means of the rack and pinion, presses down the hops.

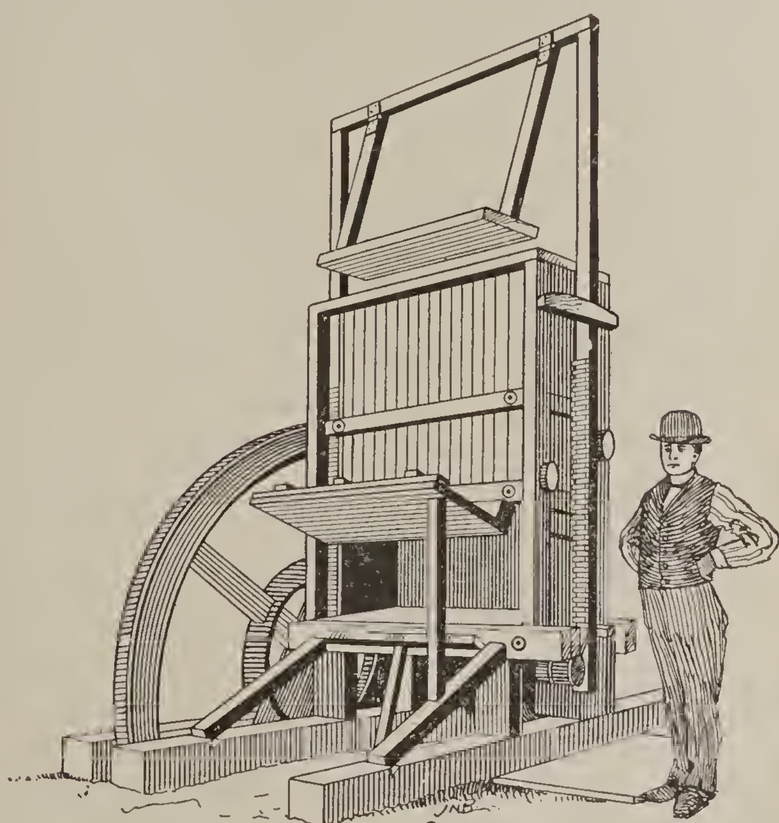


FIG. 19.—A power press operated by two horses.

The lower section of each side of the box consists of a door hinged to open upward. In baling, the bottom of the press is covered with a piece of baling cloth $2\frac{1}{2}$ yards long and from 42 to 46 inches wide, the doors are closed, the box is filled with hops, another similar cloth is spread over the hops, and the follower is brought down. The doors are then opened, the edges of the cloth sewed together with hemp baling twine, and the bale is removed from the press. The average bale from this press measures 20 by 24 by 52 inches and weighs 180 to 200 pounds.

The practice of trampling the hops to facilitate filling the box should be entirely discontinued, since the broken hops resulting therefrom detract from the selling qualities. While filling the box the corners of the bale may be slightly tamped, but even this should be carefully done, especially if the hops are dry. More careful handling is urged, as the hops are often broken and crushed on the floor before being baled and this gives them a bad appearance.

Hops are baled in jute bagging, 16 threads or less to the inch. About 5 running yards of bagging are required for each bale. This weighs from $7\frac{1}{2}$ to 10 pounds, and for it 5 pounds tare is allowed in selling.

COST AND YIELD OF CROP.

The cost of production varies so greatly, owing to differences in the value of land, price of labor, yield, and methods of operation in different sections of the United States, that it is not feasible to attempt to estimate the total expense of producing a crop. The danger of loss incident to unfavorable weather or attacks of insect pests renders hop growing much more precarious than raising other staple crops. The difficulty of securing sufficient help at picking time has added much to the hazards of the crop in recent years. Some estimates of the more important expenses of production are as follows:

Important items of cost in hop production.

Roots	per thousand	\$2.00	to	\$8.00
Trellis	per acre	80.00	to	90.00
Twine	do	4.00	to	7.00
Cultivating	do	6.50	to	18.00
Training	do	11.00	to	22.00
Spraying	do	4.00	to	12.00
Picking	per dry pound	.03½	to	.05
Curing	do	.01	to	.01½
Baling:				
For cloth and twine	per bale	.60	to	.90
For labor	do	.15	to	.25
Hop press		30.00	to	400.00

The yield varies widely according to the locality, and within the locality according to soil conditions. In the following table is shown the average production of hops per acre for the principal hop-growing States, according to the report of the United States Census for 1900:

Table 1.—*Average production of hops to the acre in the United States for the years 1879, 1889, and 1899.*

States.	1879.	1889.	1899.
	Pounds.	*Pounds.*	*Pounds.*
New York	554	547	630
Oregon	840	1,155	951
California	1,022	1,648	1,469
Washington	1,317	1,626	1,287

In seasons of good production, on the better soils, the yield will usually be much larger. In California an acre may produce 1,800 to 2,400 pounds; in Washington, 1,200 to 2,000 pounds; in Oregon, 1,000 to 1,600 pounds, and in New York, 800 to 1,500 pounds.

The following figures from Bulletin No. 50 of the Bureau of Statistics, United States Department of Agriculture, give the ap-

proximate annual production for the United States as compiled from unofficial estimates for the years 1901-1906:

TABLE 2.—*Annual production of hops in the United States from 1901 to 1906, inclusive.*

States.	1901.	1902.	1903.	1904.	1905.	1906.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
New York	9,000,000	5,850,000	9,000,000	11,880,000	9,360,000	12,060,000
California	9,360,000	10,335,000	10,920,000	12,285,000	14,235,000	20,475,000
Oregon	13,845,000	16,965,000	17,550,000	17,550,000	22,191,000	23,985,000
Washington	6,630,000	5,850,000	6,825,000	7,410,000	9,750,000	8,775,000
Total	38,835,000	39,000,000	44,295,000	49,125,000	55,536,000	65,295,000

MARKETING.

The most serious problem confronting the hop grower is how to market his product at a figure which will give a fair return for investment and labor. Owing in part to great fluctuations in prices, hop growing from a business point of view is extremely variable and uncertain. The state of the market is determined largely by the stock of hops held in storage from the previous year, by the crop conditions at home and abroad during the current year, and by the probable demand as judged from a comparison of the two conditions just mentioned. While the state of the market is conditioned by these three factors, it is influenced heavily by the dealers, hop merchants, or middlemen who stand between grower and consumer.

Hops may move into the market in a number of ways and reach the consumer through various channels. The relations of grower and consumer in some of the more direct lines of transfer are illustrated in the accompanying diagram (fig. 20).

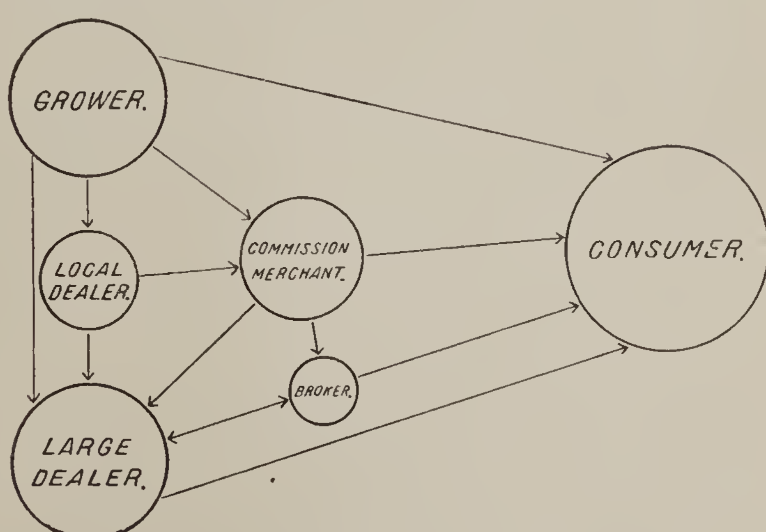


FIG. 20.—Diagram showing movement of hops into market.

Only a small percentage of hop growers sell direct to consumers, so the bulk of the trade passes through the hands of middlemen. Sales may be made to the large dealer direct through his buyers or to the local dealer, who in turn sells to the large dealer; or growers may sell through a commission merchant who may act as agent for both grower and consumer. The broker, or factor, serves as a go-

between for dealers or for dealer and consumer. All these middlemen occupy a recognized legitimate place in the trade so long as they confine their operations to buying and selling at market prices as fixed by supply and demand and depend for their profits upon the favorable terms which they may be able to make in the regular course of trading. Under existing conditions the hop crop could not be marketed without the middlemen. Growers with small holdings remote from consumers could scarcely find a market for their product, even if the difficulties involved in arranging credit were overcome. The grower is usually in need of money and demands immediate payment; on the other hand, the consumer may not have funds available to pay cash for his hops at the time when it is necessary to make the purchase. The dealer solves the difficulty by relieving the grower of his stock and making cash payment therefor or a suitable short-time arrangement and by selling to the consumer on terms to suit his convenience.

Although much significance is commonly attached to the locality in which the hops are produced, it is apparent that too much emphasis is laid on geographical origin as a standard of quality. It has been repeatedly demonstrated that dealers and consumers can not tell with certainty the section of the country a sample comes from by examination alone. Even samples from the same yard, when the conditions of drying have differed somewhat, have been ascribed to widely different sections by expert judges of hops.

The price which a consumer will pay for hops depends largely on their origin, thus making it frequently possible to deliver hops grown in one section when the sale was made on hops from another which commanded a different price. Unfortunately, there is no definite standard of quality in judging hops, and there is apparently too much importance attached to origin alone. While geographic origin may be of some importance, its usefulness as a standard of quality is small compared with the tests usually applied in judging the value of hops. In determining the relative quality of different lots of hops a fixed standard of valuation founded on intrinsic qualities rather than preference would be exceedingly valuable to both producer and consumer.

The present unsatisfactory conditions of marketing offer opportunities for improvement along several lines. One of the greatest needs of the hop industry is more complete and accessible statistics of production and consumption, not only that growers may govern their acreage by the prospective demand, but that, by knowing the amount consumed during the current year, the stocks remaining in the hands of the consumers, and the crop conditions at home and abroad, an intelligent opinion may be formed as to the probable rela-

tion between supply and demand and what prices may therefore be reasonably expected. From the return made by the officers of the internal-revenue service a quarterly statement would show the total amount of hops consumed, and from the consumption—its increase or decrease—the market possibilities could be inferred. Also the necessity is very great for frequent reliable statements of European crop conditions. The hop market is controlled by the production in the United States, England, Germany, and Austria; and, since the surplus production of the United States is exported almost entirely to England, crop conditions abroad practically control American prices. More reliable and detailed statistics of home production are needed. So many exaggerated reports are circulated for the purpose of influencing the market that an exact census of the acreage set out, the acreage harvested, and the number of bales produced would be of incalculable benefit to the producer; and this end would be much furthered by thorough cooperation on the part of the hop growers themselves.

On the Pacific coast several hop growers' associations have been organized along similar lines and with the same general purpose as the citrus growers' associations and others in southern California. Other organizations modeled along the lines of the hop growers' associations or cooperative unions of Europe should enable growers to protect their interests better and to secure recognition unobtainable as individuals. The industry is so centralized in the various States that a very small number of associations could easily include practically all the growers in their membership. With proper cooperation on the part of the members of the associations and the abandonment of the attitude of suspicion and distrust which too often characterizes the relations of producers with each other, it should be possible for growers to secure the adequate collection and distribution of the most necessary statistics of production and consumption and to more fully acquaint themselves with the need of better methods and of greater facilities for handling the business.

O

...ber ein allgemeines Kopfschütteln begegnet, da das Budget nur die Betriebs-...nahmen und -Ausgaben unter dem Titel „Verkehrsanstalten" erscheinen ließ: ...e Kapitalien und die Verzinsung der Eisenbahnschuld sind aber unter dem ...itel „Staatsschulden" vorgetragen, die Pensionen des Personals wieder ...ter einem besonderen Titel, dagegen aber die Abschreibungen für Abnützung ...r nirgends. Die Anhänger des kameralistischen Systems sagen noch weiter, ...e Einführung der kaufmännischen Buchführung sei mit „erheblichen" Um-...ändlichkeiten verbunden: Die beteiligten Beamten müßten diese Methode ...t „lernen". Was soll man nun dagegen sagen? Nichts, das wird das ...ste sein.

B. M.

Hopfenbau und Hopfendarren in den Vereinigten Staaten.

I.

...on W. W. Stockberger, Sachverständiger in Drogenpflanzen-Untersuchungen, Büreau ...r Pflanzen-Industrie, Vereinigte-Staaten-Departement für Landwirtschaft. (Aus „American Brewers Review" 1907, Nr. 11 und 12 und 1908 Nr. 1, 2 und 4.)

Einleitung.

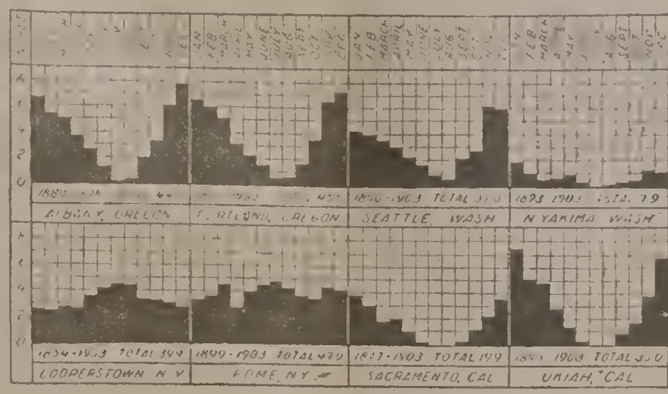
Im Einklang mit den großen Fortschritten, welche die Landwirtschaft in ...en letzten Jahren gemacht hat, sind auch die Methoden der Hopfenproduktion ...icht unverändert geblieben. Trotzdem verdienen gewisse praktische Grundsätze ...on großer Wichtigkeit für den erfolgreichen Hopfenbau viel ausgedehntere Beachtung, als ihnen gegenwärtig zuteil wird. Dieselben sollen in den nach-...tehenden Ausführungen besprochen werden, in denen auch eine kurze allgemeine Darstellung des Hopfenbaues gegeben ist. Es liegt auf der Hand, daß es ...nmöglich ist, in allen Einzelheiten Methoden des Hopfenbaues anzugeben, welche in allen Teilen der Vereinigten Staaten Anwendung finden können. Die eigentümlichen klimatischen und Bodenverhältnisse, sowie die Lage be-...influssen die herrschenden Methoden des Baues, sowie die angebauten Varietäten und erlegen dem praktischen Hopfenbauer die Pflicht auf, solche Methoden zur Anwendung zu bringen, welche seiner Erfahrung nach am besten für die in dem gegebenen Falle vorliegenden Bedingungen geeignet sind.

Das Keimen.

Die Hopfenpflanze läßt sich überall in den Vereinigten Staaten bauen, doch ist ihre Kultur für den Markt praktisch auf gewisse Landstrecken in den Staaten Oregon, Kalifornien, New-York und Washington beschränkt. Geringe Mengen werden ferner in Wisconsin, Idaho, Massachusetts, Pennsylvanien, Michigan, Vermont, Kentucky und Ohio erzeugt. Die beigegebene Karte (Fig. 1)

Figur 1. Verteilung der hopfenbautreibenden Länder in den Vereinigten Staaten.
. Gegenden, in denen der Hopfen als Handelsware gebaut wird.
° Gegenden, die weniger als 1500 Pfund produzieren.

veranschaulicht die Verteilung der hopfenerzeugenden Gegenden der Vereinigten Staaten und stellt graphisch dar, wie sich die Industrie in Bezirken, welche die günstigsten Bedingungen liefern, lokalisiert hat. Lange, strenge Winter töten oft viele Pflanzen, und auf anhaltend feuchtes oder nebliges Wetter folgt gewöhnlich ein heftiger Angriff von Läusen oder Schimmel. Obgleich aus der Karte hervorgeht, daß Hopfen unter sehr verschiedenen klimatischen Bedingungen gezüchtet wird, so baut man ihn mit dem besten Erfolg in den milderen Gegenden, wo auf reichlichen frühen Regen warmes, trockenes Wetter folgt, wenn die Pflanze sich der Reife nähert. Die Karte (Fig. 2) zeigt den



Figur 2. Darstellung der Niederschlagsmengen in den Haupt-Hopfenländern der Vereinigten Staaten.

durchschnittlichen monatlichen Regen in den hauptsächlichen hopfenbauenden Landstrecken der Vereinigten Staaten. Im Yakimatale in Washington, wo der Regen sehr mangelhaft ist, ist künstliche Berieselung erforderlich. Die Hopfenpflanze paßt sich leicht sehr verschiedenen Bedingungen in Bezug auf Niederschläge an, wenn aber die Erntemonate — August und September — viel Regen bringen, so erleidet die Ernte oft schwere Schädigung durch Läuse und Schimmel.

Der Boden.

Bei der Auswahl des besten Bodens zum Hopfenbau sprechen verschiedene Faktoren mit, welche von den Eigentümlichkeiten der Pflanze selbst, sowie den physikalischen Verhältnissen der Gegend, wo das Land liegt, abhängen. Im allgemeinen gibt man reichem Alluvialboden oder tiefem, sandigem oder kieshaltigem Lehm den Vorzug. Ein stark sandiger Boden erleichtert den Anbau, während die Bearbeitung eines steifen Bodens schwer und kostspielig ist. Infolge der Verschiedenheit in Regen, Sonnenschein und Heftigkeit der herrschenden Winde kann ein in einer gewissen Gegend zum Hopfenbau taugliches Land gänzlich ungeeignet sein, wenn es in einer anderen Gegend liegt. Da die Wurzeln der Hopfenpflanze viele Fuß tief in die Erde eindringen, so ist ein gut drainierter Unterboden wesentlich. Besondere Aufmerksamkeit erfordern Tiefe, Fruchtbarkeit, Drainage und Feinheit des Bodens. Man vermeidet schwere, nasse, sowie steife, tonhaltige Böden.

Fortpflanzung durch Samen.

Man kann Hopfenpflanzen aus Samen züchten, doch findet diese Methode selten Anwendung, weil sich durch Ableger leichter und schneller kräftige Pflanzen erzielen lassen. Ferner haben die aus Samen gezüchteten Pflanzen die Neigung, sich stark zu verändern, sowohl hinsichtlich der Zeit der Reife als auch der Qualität des Produktes. Mit Pflanzen, die aus Samen gezogen sind, angebaute Gärten zeigen in der Regel mangelhafte Gleichmäßigkeit in der erzeugten Hopfenvarietät und in der Zeit der Reife. Aus Samen gezüchtete Pflanzen liefern das erste Jahr keinen Hopfen, und im zweiten Jahre kann man nur auf einen geringen Ertrag rechnen.

In den Niederlanden braute man ein Bier, das Grotbier genannt wurde, das wohl „Kräuterbier" sein soll, und bei dem die Kräuter als Gärungsmittel dienten. Dieses Bier wird in einer Urkunde vom Jahre 1260 ausdrücklich „Fermentum" genannt, ein Beweis, daß bei ihm die Gärung und der Absatz von Hafer die Hauptsache war.

Uebrigens begegnet uns der Name eines gegorenen Bieres, Gruit, schon in einer Urkunde Ottos III. von 939. Endlich gab es auch recht schlechtes Bier, das aus Hafer gebraut war, und wozu anstatt des Hopfens nur Eschenblätter genommen wurden, wie dies die genannte Hildegardis bezeugt. Im 14. Jahrhundert scheint das Lagerbier aufgekommen zu sein. Zwar wird uns bereits vom Jahre 1090 erzählt, daß die Nonnen im Stifte Freckenhorst im Münsterlande altes und neues Bier erhalten hätten; aber in den Statuten der Stadt Ulm vom Jahre 1350 lesen wir zuerst, daß nur von Michaeli bis Walpurgis gebraut werden durfte, wie denn zu gleicher Zeit in der Stadt Zittau die Ordnung bestand, zweierlei Bier zu brauen, Weizen- oder Tränkebier für den sofortigen Gebrauch und Gersten- oder Lagerbier.

Ebenso schien man früh in den Klöstern einen Unterschied zwischen gutem und minderem Biere zu machen, und aus dem Jahre 1482 ist uns bekannt, daß die Klöster zweierlei, ein stärkeres (Paternus) und ein schwächeres (Koventbier) gebraut haben. Nebenbei sei bemerkt, daß das ganze Mittelalter neben dem Bier viel Met braute, der selbst dem Weine gleichgestellt wurde, so besonders in Schwaben, den Niederlanden und Sachsen. In den Niederlanden soll er (der Met) am schmackhaftesten gewesen sein, namentlich zu Brügge und Gent; in Meißen (Sachsen) aber gab es im Jahre 1015 so viel Vorrat an Met, daß bei einem großen Feuer in der Stadt infolge Mangels an Wasser der Met die besten Löschdienste verrichtete. Gegen Ende des 12. Jahrhunderts wurde Met bereits über die Donau durch Niederösterreich nach Konstantinopel und weiter nach Syrien und Palästina gesandt. Im 14. Jahrhundert werden die Metbrauereien zu Riga und Danzig genannt. Am hochmeisterlichen Hofe zu Marienburg trank man aus kleinen Schenkgläsern den reinen, guten Met; dann folgten hohe Gläser für alten und zum Teil sehr starken Met, der meist aus Riga kam. Indessen wurde der Met gegen den Ausgang des Mittelalters immer mehr verdrängt, während das Bier sich immer siegreicher in den Vordergrund stellte; wurde doch die edle Braukunst stets vorzüglicher hinsichtlich der Schmackhaftigkeit und Bekömmlichkeit ihrer Erzeugnisse.

Blicken wir aber in die vorgermanische Zeit, so finden wir schon um viele Jahrhunderte rückwärts die ersten Anzeichen des Bieres, und hätten die Egypter den Hopfen gekannt, so hätten sie um 3000 Jahre vor Christus auch schon das Bier gebraut. Annähernd 2000 Jahre vor Christus soll der König Osiris in Egypten ein aus gemälztem Getreide hergestelltes Bier eingeführt haben, und Herodot (Geschichtsschreiber) erzählt bemerkenswerterweise, daß die Egypter ihren Wein sogar aus Gerste hergestellt haben sollen, teilweise wenigstens. Auch andere Geschichtsschreiber des Altertums, so Archilochus, Aeschylus, Sophokles, erzählen von dem Gerstenwein, der einst „Zythos" hieß. In dieser vielfachen Annahme bemerkt Professor Riehm in seinem grundlegenden Werke „Handwörterbuch des biblischen Altertums" (a. a. O., Seite 493): „Nach der Meinung vieler sollen die Egypter Gerstensaft, eine Art Bier, getrunken haben, und dasselbe soll unter dem Gattungsnamen für ‚starkes, berauschendes Getränk' (schechar) mitbezeichnet sein. Nun haben allerdings die Egypter vor uralten Zeiten ein Zythos oder Zython genanntes Bier aus Gerste nebst einigen anderen Zutaten (nach talmudischer Angabe Krokus und Salz) gebraut, das auch in der griechischen Bibel, freilich nur vermöge unrichtiger Uebersetzung, erwähnt ist. Ebenso haben die Aethiopier, nach mehreren Talmudstellen die Medier, ferner iberische, ligurische, phrygische, thrakische, armenische und besonders keltische Stämme (die Germanen erst, seit sie sich dem Ackerbau zuwendeten) einen die Stelle des Weines ersetzenden Gerstensaft getrunken. Aber daß in dem Weinland Egypten Bier gebraut worden ist, kann daraus, daß Talmudisten und Rabbiner jenen Gattungsnamen dafür gebraucht haben, nicht so ohne weiteres bewiesen werden, da noch im Talmud die Erinnerung, daß das Bier ein ausländisches, egyptisches oder medisches Getränk war, sich deutlich kundgibt, und ist bei dem Mangel jeder Hindeutung auf solche Verwendung der Gerste im alten Testament im höchsten Grad unwahrscheinlich. Der Gelehrte steht also der allgemein verbreiteten Ansicht, daß die alten Egypter sich das Bier selbst brauten, entgegen. Auf der anderen Seite aber soll die Kunst ja selbst von einem heimischen König (Osiris) dem Volke der Egypter gelehrt worden sein*). Bei den Phrygern und Thrakern, die gute Biertrinker gewesen sein sollen, hieß das Bier Bruton, und Archilochus erzählt von ihm. Auch Xenophon berichtet (nach Geroldinq, Becheralphabet, Leipzig) in der Anabasis von einem starken, betäubenden Getränke, einem Gerstensaft, der durch Rohrhalme aus Krügen getrunken wurde, und in dem noch die Gerstenkörner umherschwammen.

Aber nicht allein Egypten ꝛc., sondern auch das spätere klassische Land Rom kannte das Bier. Die Römer nannten das Bier Gabe der Teres-Cerevisia; die Spanier tauften es „Terna"; Plinius (Geschichtsschreiber)

*) Die Pelusier, die Bewohner der edlen Stadt Pelusium, an einer der Nilmündungen gelegen, sollen in grauen Zeiten die besten Bierbrauer gewesen sein, daher man noch heute das Bier als ein pelusisches Getränk bezeichnet. Bei ihnen hieß das Bier ebenfalls Zythos, und sie mischten es mit Kümmel und mit Lupinenbitter.

Fortpflanzung durch Setzlinge.

Die einfachste Züchtung von Hopfenranken geschieht mittels Ableger von den Wurzeln, auch „Wurzeln" oder „Setzlinge" genannt. Die zahlreichen Ausläufer an der Oberfläche, welche die Hopfenpflanze aussendet, werden beim Beschneiden im Frühjahr entfernt, und nachdem sie in Stücken mit wenigstens je zwei Gruppen „Augen" oder Knospen zerlegt sind, zur Züchtung neuer Pflanzen verwendet. In einigen Teilen der pazifischen Küste läßt sich von den im Frühjahre gepflanzten Ablegern bereits eine Ernte erzielen, doch erhält man in der Regel eine volle Ernte erst im zweiten Jahre. Die besten Ableger stammen von jungen Pflanzen, da sie Krankheiten besser Widerstand leisten und ertragreicher sein sollen als solche von alten Pflanzen. Alle Ableger müssen vor dem Pflanzen sorgsam geprüft und erkrankte oder schadhafte weggeworfen werden.

Züchtung neuer Varietäten.

Der wichtigste Gegenstand der Züchtung neuer Varietäten, sowie der nicht weniger vielversprechende der Veredlung bestehender Varietäten verdient die Aufmerksamkeit eines jeden Hopfenbauers. Die Pflanzen auf jedem Felde sind mehr oder weniger veränderlich. Einige sind ertragreicher als andere, einige sind reicher an den wünschenswerten Harzen, und einige weisen andere wertvolle Eigenschaften auf. Neue Varietäten können unter den Pflanzen in der Pflanzenschule, wenn dieselben aus Samen gezogen werden, gesucht werden. Nachdem die aus Samen gezogenen Pflänzchen in die Gärten umgepflanzt sind und einmal getragen haben, kann eine sorgfältige Prüfung bei der Pflücke ergeben, daß gewisse Pflanzen bessere Eigenschaften besitzen. Diese sind dann passend zu bezeichnen und nächste Saison zwecks weiterer Auswahl Ableger davon zu nehmen. Es ist kein Grund ersichtlich, warum diese Methode bei genügender Beharrlichkeit nicht dazu führen sollte, daß wertvolle neue Varietäten erzeugt werden. Die mit neuen und veredelten Varietäten von Mais, Weizen, Weintrauben und anderen Früchten erzielten günstigen Resultate können sich bei der Hopfenkultur wiederholen lassen und deuten an, in welchen Richtungen die Veredlung fortgesetzt werden kann, besonders hinsichtlich der Verbesserung der Qualität des Produktes. Die Gelegenheit zur Erzeugung edlerer Sorten durch Auswahl der Stöcke, von denen Ableger geschnitten wurden, eröffnet dem fortschrittlichen Hopfenbauer ein verheißungsvolles Feld. Viele Züchter, welche große Aufmerksamkeit auf die Fruchtbarkeit ihrer Felder und die Methoden der Bodenbearbeitung verwenden, entnehmen die Setzlinge zur Anlage von Hopfenpflanzungen den ersten besten Hopfengärten, ohne die Produktivität und anderen Eigenschaften der Pflanzen, von denen die Setzlinge herstammen, in Betracht zu ziehen. Dies hat in vielen Pflanzungen dazu geführt, daß gewisse Charaktere der Varietät verloren gingen, und auf fast allen Feldern kommen gemischte Varietäten und Individuen mit reichem und armem Ertrage nebeneinander in planloser Weise vor.

Eine entschiedene Verbesserung der Qualität sollte auf die sorgsame Auswahl der Setzlinge hinsichtlich der Produktivität, der Gleichförmigkeit, der Widerstandsfähigkeit gegen Krankheiten und der allgemeinen Fähigkeit der Anpassung an die Bedingungen in der Gegend, in denen die Pflanzen wachsen sollen, folgen. Die Auswahl soll zur Zeit der Pflücke stattfinden, wo solche Hügel mit Pflanzen von hervorragender Güte und Ertragsfähigkeit bezeichnet werden können, sodaß in der nächsten Saison die Setzlinge davon geschnitten werden können.

Fig. 3. Ein Hopfenfeld (Stangenanlage).

Die Zeit zum Pflanzen.

Die Zeit, in der das Pflanzen stattfinden soll, hängt zum großen Teil von den lokalen Verhältnissen an dem Orte, wo der Hopfen gebaut werden soll, ab, doch läßt sich im allgemeinen sagen, daß die besten Resultate erzielt werden, wenn mit dem Pflanzen begonnen wird, sobald sich der Boden fein und mürbe arbeiten läßt. In Kalifornien soll man im Januar oder Februar pflanzen, obschon in einigen Jahren auch dann gute Resultate erzielt wurden, wenn man erst am 1. Mai die Stöcke umpflanzte. In Oregon und Washington pflanzt man die Hopfen im März oder April, und in New-York hat man in günstigen Jahren im April mit Erfolg gepflanzt.

Fig 4. Landstraße zwischen Hopfenfeldern, mit Hopfenranken auf Hochgerüst an beiden Seiten.

Das Einpflanzen.

In Kalifornien pflanzt man fast überall die neuen Hopfen in Reihen, die nach beiden Richtungen $6\frac{1}{2}$ bis 7 Fuß voneinander entfernt stehen. Bei einem Abstande von $6\frac{1}{2}$ Fuß ergeben sich 1031 Hügel auf den Acre und $42\frac{1}{2}$ Quadratfuß Boden auf jeden Hügel; bei 7 Fuß Distanz ergeben sich 898 Hügel für den Acre und 49 Quadratfuß Boden für die Pflanzen jedes Hügels. In Oregon und Washington, wo man zur Bodenbearbeitung Zweispänner benützt, nimmt man in der Regel eine Distanz von 8 Fuß zwischen den Reihen, was 680 Pflanzen für den Acre erfordert.

Die Art der Bodenbearbeitung in den Hopfengärten macht gerade Reihen notwendig. Man setzt drei und oft vier Setzlinge in jeden Hügel. Es herrschen

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nannte es „Terevisia". Aristoteles spricht ebenfalls von einem starken Getränke aus Malz; Theophrast spricht von Gerstenwein. Bevor die alten Gallier unter Roms Herrschaft sich beugen mußten, kannten sie das Bier nicht minder, wie skandinavische Sagen beweisen, daß das Bier in den nördlichen Landen, den Regionen des Schnees und Eises, bekannt war.

So viel vom Bier, und nun zum Bierbrauen selbst. Rehlen schreibt, daß das Bierbrauen im Mittelalter und ebensolange Zeit nachher wie vorher das Geschäft der Frauen war, und daß die Fähigkeit, gutes Bier brauen zu können, eine große Frauentugend war. In den nordischen Haushaltungen stand die Frau, und wäre sie eine Königin, selbst am Kessel und braute das Bier. Erst später, mit der eintretenden Städteblüte, konnte sich ein selbständiger Bierbrauerstand entwickeln. Am frühesten werden einzelne Städte in den Niederlanden genannt, in denen das Biergewerbe flott im Gange war, wie z. B. Bemenel in Geldern bereits 999; dann in Utrecht Mußfort, in Holland Delft, in Brabant Nivelle (1209), in Flandern Brügge, Gent und einige andere, deren Biere bis nach Preußen geführt wurden. Auch in Köln war das Bierbrauen seit Beginn des 13. Jahrhunderts ein häufiger Gewerbszweig. In demselben Jahrhundert wird von einem starken Bierhandel in Bremen und Hamburg (1270) berichtet; später werden auch Magdeburg und Bernau genannt. Das zittauische Bier, das schon 1270 genannt wird, wurde viel nach Prag ausgeführt, besonders um 1380. Das Lübecker Bier ging in derselben Zeit häufig nach dem Norden, und dänische und schwedische Könige, Grafen und Edelleute wußten sich selten etwas Besseres zugute zu tun als lübeckisches Bier. Im Süden Deutschlands ist besonders Regensburg zu nennen, wo seit dem 11. Jahrhundert der Hopfenbau gepflegt wurde, und wo in der ersten Hälfte des 13. Jahrhunderts das Brauwesen allgemein war.

War das Brauen erst allgemein frei, so riß die Braugerechtsame bald die einzelnen Zünfte an sich, sobald sich ein größerer Bierbrauerstand in den Städten entwickelt hatte. Nachdem erst der Stand der Brauer ein fester war, währte es nur kurze Zeit, als auch die erste Biersteuer auftauchte. In Ulm treffen wir sie um 1255 zuerst an. Wurde aber in manchen Städten aus Mangel an gutem Wasser und gutem Keller oft sehr schlechtes Bier gebraut, so ließ der löbliche Rat selber fremdes Bier kommen und dasselbe in eigenen Schenken ausgeben; so entstanden die Ratskellerwirtschaften. Der Rat von Erfurt löste im Jahre 1463 von aus Naumburg bezogenem Bier einen Gewinn von 6104 Gulden. In anderen Städten, wo man den eigenen Bierbrauern [illegible] wollte, versuchte man das sogenannte Meilenrecht auch auf das Bier[illegible] auszudehnen; nach diesem Rechte durfte kein innerhalb einer Meile von der Stadtgrenze wohnender Gutsherr ein Brauhaus oder selbst nur eine Schenke errichten. Gegen dieses Meilenrecht suchten sich die Gutsherren zu wehren, indem sie sich eigene landesherrliche Brau- und Schankgerechtsame verschafften. So wurde nach und nach das Bierbrauen ein Regal der Landesherren.

Mit dem Ende des Mittelalters geht manches Große und Gewaltige dahin, aber nicht das Bier, das seine Herrschaft immer mehr ausbreitet, je mehr sich die Kunst des Brauens entwickelte. Und eine ganze Reihe von Städten tritt auch auf, die durch ihr besonders gebrautes Bier eine Berühmtheit erlangten. Solche Berühmtheit erlangte einst die „Mumme", ein Bier, von einem Braunschweiger Bürger namens Christian Mumme erfunden. Es ist oder war dies Bier aus Weizen und wurde dereinst in zwei Sorten, als Stadtmumme und als Schiffsmumme, gebraut. Sein Geschmack war süßlich. Einstens weltberühmt, sank es nach und nach zum Braunschweiger Nationalgetränk herab. Das Geburtsjahr des Bieres fällt mit dem Entdeckungsjahr Amerikas zusammen, ist also 1492. Neben der Mumme wurde berühmt das märkische Bier, das bis nach England ging. Ferner das einbeckische Bier, von dem Herzog Erich von Braunschweig Luther auf dem Reichstag zu Worms eine Flasche zugeschickt hatte. Der große Biergelehrte Plakotomus (zu gut deutsch Bretschneider) hat in seinem Buch „De natura cerevisiarum" ihm und ebenso der Mumme viele schönen Eigenschaften nachgerühmt und sagt u. a. vom Einbecker Bier: „Für Fieberkranke gibt es nichts Angenehmeres, kaum etwas Heilsameres." Klaus Magnus, der im 16. Jahrhundert lebende Erzbischof von Upsala, schreibt im 13. Buche seiner Historien: „Das Einbecker sagt am meisten zu im Sommer bei würgendem Durste" (Gerolding, a. a. O., Seite 21). Weiter war das Merseburger Bier als besonders sehr magenstärkend um jene Zeit berühmt. Außer diesen und anderen starken und bitteren Braunbieren wurden auch Weißbiere gebraut, unter denen die Gose von Goslar und der Broyhan von Hannover an erster Stelle standen. Der Broyhan ist ein nach seinem ersten hannoverschen Brauherrn benamstes Weißbier. Ueber den Halberstädter Broyhan schrieb der Gelehrte Schookius in seinem Opus „Liber de cerevisia" folgendes hyperbolisches Distichon:

Grandia si fierent summo convivia coelo Breihanum superis Jupiter ispe daret, was zu deutsch besagt: „Es würde bei einem Himmelsbankett selbst Jupiter seinen erhabenen Kollegen mit Broyhan (Breyhan) bewirten." (Gerolding.) Allen diesen verschiedenen Bieren wurden nun trotz der ernsten Tage jener Zeiten allerlei Spott- oder auch Kosenamen gegeben; so wurde u. a. das Bretzenburger Bier „Kerl", das Breslauer „Schöps", das Königslutter „Duckstein", das Kottbuser Weißbier „Krabbel an die Wand", das

Unterschiede in Meinungen und in der Praxis, und die Zahl der zu pflanzenden Setzlinge hängt in gewissem Grade ab von dem System des Ziehens der Ranken und dem Preise der Wurzeln. Das Setzen einer vierten Wurzel ist eine Vorsichtsmaßregel gegen die Möglichkeit des Verlustes durch Verfaulen oder Schädigung eines oder mehrerer Setzlinge nach dem Einpflanzen.

Eine gute Methode zum Setzen der Wurzeln besteht darin, daß man den Mittelpunkt eines jeden Hügels mit einer kleinen Stange bezeichnet, an welcher die Stränge für die Ranken befestigt werden; dann macht man um die Stange herum drei Löcher, welche ungefähr die Spitzen eines gleichseitigen Dreiecks mit einer Seite von sechs Zoll bilden. Diese Löcher werden mit einem Pflanzstock gemacht, doch nimmt man bei sehr festen Böden oft ein Brecheisen. Dann steckt man die Wurzelstöcke einzeln in diese Löcher in aufrechter Stellung mit den Knospen nach oben, und zwar so tief, daß sie von einem Zoll (in Oregon) bis drei Zoll (in Kalifornien) unterhalb der Oberfläche liegen. Dann wird die Erde leicht um sie herum festgestampft. Nach einer anderen Methode gräbt man mit einem Spaten ein Loch an der Stelle, wo der Hügel stehen soll, und pflanzt darin eine bis vier Wurzeln, jenachdem, wie kräftig sie sind. Dieses ist ein schnelleres Verfahren, aber weniger empfehlenswert, weil die Wurzeln zusammengedrängt werden und leichter dem Verderben ausgesetzt sind. Der Preis der Wurzeln ist sehr abweichend und schwankt von einem Dollar für 1000, wenn sie reichlich vorhanden sind, bis zu acht Dollar oder zehn Dollar für 1000, wenn sie selten sind.

Die Bodenbearbeitung.

Gründliche Bearbeitung des Bodens ist von Wichtigkeit und soll früh angefangen und fortgesetzt werden, bis die Pflanzen gut Seitenarme gebildet haben. Dies ist notwendig nicht allein, um das Unkraut hintanzuhalten, sondern auch, um zu verhindern, daß der Boden eine Kruste bildet und hart wird, denn wenn er sich in diesem Zustande befindet, steigt die Feuchtigkeit aus den unteren Bodenschichten empor und verdampft schnell. Häufiges Auflockern des Bodens bis zu einer Tiefe von zwei bis drei Zoll liefert eine Lage fein zerteilten Bodens, welcher die Feuchtigkeit nahe an der Bodenfläche hält, wo sie leichter für die jungen Saugwurzeln zu erreichen ist, welche sich etwa um die Zeit bilden, in der die Pflanzen die Dolden ansetzen. Wenn diese kleinen Saugwurzeln durch zu spätes Auflockern des Bodens zerstört oder schwer beschädigt werden, so wird das Wachstum aufgehalten, und es tritt zu frühes Reifen ein. Aufmerksame Hopfenbauern stimmen darin überein, daß die jungen Blütenknospen sich nicht so gut ansetzen, wenn die Saugwurzeln ernstlich gestört werden, und der Ernteertrag infolgedessen kärglicher ausfällt. Trotzdem kann es unter Umständen, wenn der Boden hart wird und die Feuchtigkeit zu schnell verdampft, wenigstens in trockenen Jahren angezeigt sein, nochmals aufzulockern und darauf zu rechnen, daß die Saugwurzeln nachwachsen, um die Ernte gut zur Reife zu bringen. Die bestehenden Bodenverhältnisse müssen in Bezug auf das Aufhacken nach dem Auftreten der Saugwurzeln maßgebend sein.

Das Beschneiden.

Durch Beschneiden werden die überschüssigen Ausläufer von dem Wurzelstock entfernt und die Bildung von weniger, aber stärkeren Ranken gefördert. Der Wurzelstock wird dabei auf eine annehmbare Form und geeignete Tiefe unter die Erde gebracht und die Bildung von unerwünschten Ausläufern eingeschränkt oder verhindert. Die bei dem Beschneiden notwendige Bearbeitung des Bodens bildet ebenfalls einen wichtigen Teil der Kultivierung. Innerhalb gewisser, durch örtliche Verhältnisse bestimmter Grenzen kann die Periode des Wachstums und die Zeit der Reife durch frühes oder spätes Beschneiden beeinflußt werden. Der allgemeinen Praxis gemäß beschneidet man früh im Frühling, wobei der genaue Zeitpunkt von der Saison und der Oertlichkeit abhängt. Es herrscht vielfach der Brauch, vier oder fünf Furchen mit einem kleinen Pfluge an beiden Seiten der Reihe zu ziehen und die Erde von den Hügeln wegzuwenden. Dann wird kreuzweis in derselben Weise gepflügt, sodaß jeder Hügel ein kleines Quadrat ungestört beherrscht. Dann wird die Erde aufgehackt und von den Wurzeln weggehoben, und die überschüssigen Wurzeln und Ausläufer werden mitsamt einem Stück von einem bis zwei Zoll Länge von dem oberen Ende der Wurzelkrone mit einem scharfen Messer abgeschnitten. Nach dem Beschneiden wird die Erde mittels der Hacke auf den Hügel zurückgeworfen und der Wurzelstock zwei bis drei Zoll tief bedeckt. Zu viel Beschneiden auf diese Art gibt Veranlassung zu Krankheit, und oft hat ungleichmäßiges Beschneiden ein spätes Aufgehen der zu stark beschnittenen Ranken zur Folge.

Ein anderes Verfahren, welches gewisse Vorteile dem obigen gegenüber voraus hat, besteht darin, daß man den Boden wie oben mittels Pflügens vorbereitet und beim Ziehen der beiden letzten Furchen ein Pflugmesser (coulter) an dem Pfluge benützt. Man gräbt dann den Hügel nicht auf, sondern nimmt statt dessen einen scharfen Spaten und schneidet damit die Seiten des Hügels schräge von oben nach unten ab, sodaß derselbe etwa vier Zoll im Quadrat oben, und 12 bis 14 Zoll im Quadrat unten mißt. Hierdurch wird das Härten des Landes durch die Sonne verhindert, und die neuen Schößlinge kommen leicht hindurch. Das Beschneiden fällt gleichförmiger aus, und der Wurzelstock leidet weniger von Wunden und Verletzungen als bei der ersteren Methode.

Die Gerüste.

Mit Ausnahme der hopfenbauenden Gegenden im Staate New-York hat man den Gebrauch von Hopfenstangen in jenen Gegenden, wo es wenig brauchbares Holz gibt, zum großen Teile aufgegeben, und selbst in stark bewaldeten Gegenden haben viele Pflanzer sich von denselben abgewendet. Dies ist nicht allein der mit denselben verbundenen Arbeit und Kostspieligkeit zuzuschreiben, sondern die Erfahrung hat gezeigt, daß die Vorteile des Hopfenbaues mit Drähten gegenüber der Verwendung von Stangen so bedeutend sind, daß es nur noch eine Frage der Zeit ist, bis die Stangen vollständig verbannt sein werden. Die Hopfen bleiben an den Drähten gesunder, sind besser zu waschen, reifen früher, sind meist reicher und heller, verzweigen sich weiter unten und sind nicht so stark belaubt; sie lassen sich nicht so leicht vom Winde umherpeitschen und sind zur Pflücke leichter abzunehmen. Auch lassen sich die Hopfen pflücken, ohne die Ranke zu schneiden, was schädlich ist, weil es die Rückwanderung der Stoffe aus der Ranke in die Wurzel verhindert und durch den daraus sich ergebenden Ausfall an der Nahrungsmittelreserve in der Wurzel das Wachstum in folgenden Jahren schwächt.

Fig. 5. Hopfenfeld, Senkdrahtgerüst und Pflückmethode.

Für einen dauernden Hopfengarten gibt ein Drahtgerüst in einer oder der anderen Form in den meisten Gegenden wohl die besten Resultate. Wo reichlich Holz vorhanden ist, dürften die ersten Anlagekosten diejenigen der Stangen wohl etwas übersteigen, allein die Arbeitsersparnis, die Vorteile beim Waschen und der größere Ertrag bei dieser Methode haben allgemein die Gesamtkosten der Hopfenproduktion vermindert, wo man Drahtgerüste an Stelle der Stangen eingeführt hat.

Das Drahtgerüst wird auf zahllose Weisen konstruiert, doch zerfallen diese alle in zwei Hauptklassen der Typen, das hohe und das niedrige Gerüst. Das hohe Gerüst findet die ausgedehnteste Anwendung und an demselben sind die bedeutendsten Verbesserungen vorgenommen.

Münchener Lagerbier „Bock“, das Osnabrücker „Busse“, das Wittenberger „Kater“, das Kyritzer in der Mark Brandenburg „Mord und Todschlag“ usf. genannt.

Je näher wir nun zu unserer Zeit herauskommen, desto besser werden die Erzeugnisse der Braukunst. Zunächst hat man beim Malzdarren und Malzschroten neue Vorteile erzielt, zahlreiche neue Malzdörren und Malzmühlen wurden gebaut. Neue zweckmäßige Einrichtungen und Gerätschaften erstanden in den Brauereien, der Kühlapparat fand sich ein, zu dem der Engländer Sonkey die Kühlröhren erfand; auch neue Mittel behufs der denkbar besten Gärung tauchen auf usw.

Bezüglich des Bierstoffes hat man namentlich in Frankreich, um das Malz zu sparen, häufig Stärkezucker genommen. Aber noch andere Wege wurden bezüglich der Besserung (?) des Bierstoffes gefunden. So stellte der Rittergutsbesitzer Christiania in der Londoner Ausstellung ein Schiffsbier aus, das aus Stärkezucker ohne Malz gebraut war, jedem Wechsel der Witterung standhielt, und von dem die Tonne von 100 Quart 6 Taler 20 Silbergroschen kostete. Ein Bierextrakt aus demselben Stoffe, welcher, mit Wasser vermischt, ein haltbares, gutes Bier (?) ergab, kostete der Zentner 9 Reichstaler. Zu demselben Zwecke hatte Graf Leo v. Razumowski und F. S. Pietsch von Mähren ein Malz-Hopfenpräparat unter dem Namen „Getreidestein“ auf derselben Ausstellung ausgestellt. In Kisten oder Fässern verpackt, soll sich das Präparat jahrelang gehalten haben.

Von den Bieren aber, die die edle Brauwissenschaft der durstigen Menschheit zuliebe ersann, sind es eine Reihe, die sich zu einem Weltruf emporschwangen. So nach dem Eintritt der (geschichtlich) neueren Zeit (ab dem 17. Jahrhundert) besonders das englische Zuckerbier.

Eine Steuerhinterziehung mittels Bieretiketten wird aus einer englischen Kron-kolonie Westafrikas gemeldet: Ein Steuerkommissar der englischen Regierung forderte einen handeltreibenden Negerhäuptling auf, ihm die gestempelte Urkunde vorzulegen, durch welche er berechtigt wird, sein Gewerbe auszuüben. Der dunkle Ehrenmann versicherte dem Kommissar, daß er davon überzeugt sein könne, daß diese Urkunde ganz „all right“ sei, zögerte aber, das Papier zu produzieren. Nach einigem Drängen ging er in seine Hütte, verweilte dort einige Minuten und erschien dann mit einem schmutzigen Papierfetzen, der allerdings einen Gewerbeschein darstellte. Statt des Stempels, mit welchem die Urkunden zu versehen sind, und welcher so und soviel Schilling Gebühr kostet, hatte unser so braver Häuptling, wohl aus Sparsamkeitsgründen, das E t t k e t t e i n e r B i e r f l a s c h e aufgeklebt und erklärte dem Kommissar gleichmütig, daß dies ja beinahe dasselbe sei. Ipc.

*

Trinksprüche.

Das Leben ein Traum? Die Freude ein Schaum?
So fülle mir Gambrinus den Traum tüchtig mit Schaum.

*

Er hat nicht wohl getrunken,
Der sich übertrinkt;
Wie ziemet das biderbem Manne,
Daß ihm die Zunge hinkt?

*

Das wüste Vieh hält Maß und Ziel,
Säuft nimmer, sonder Durst, zu viel;
Der Mensch nur ist so blind und toll,
Säuft wider die Natur sich voll.

*

Hast du Kummer, Liebesschmerz,
Drück' ein Seidel Bier ans Herz.

*

Zum heil'gen Christfest, da brauten einst selbst
Ihr Bier die nordischen Hausfrau'n,
Und kam's auf den Tisch, wie sah man die Lust
Aus allen Gesichtern herausschau'n.

*

Bin ganga zan Boin,
Bin duaschti sua g'west,
Dnnn waa nex im Glasla,
's vraa halmi voll Gest.
(Egeranisches Gstanzl von Gr. Cl. Zedtwitz.)

*

Guter Wein verdirbt den Beutel,
Böser schadet sehr dem Magen;
Besser aber ist's, den Beutel,
Als den guten Magen plagen.

*

Wenn Lust aus schönen Augen glänzt
Und Liebe uns den Trank kredenzt,
Dann träumen wir beim Cerevis
Uns ins verlorne Paradies.

*

Cavete ore et lingua.

*

Das hohe Gerüst.

Das Hochdrahtsystem besteht im wesentlichen darin, daß man bei jedem sechsten oder siebenten Hügel Pfosten errichtet und über dieselben hin Drähte über die Pflanzung nach beiden Richtungen rechtwinklig zueinander hinzieht. Auch an den Enden der dazwischenliegenden Reihen werden Pfosten errichtet, zwischen denen Drähte über die Reihen gezogen werden. Diese Drähte werden an die Kreuzdrähte befestigt und von den Hügeln Stränge hinaufgezogen, an denen die Ranken sich festhalten. Für die Pfosten, welche entweder aus gespaltenem oder gesägtem Holze hergestellt werden, bedient man sich eines geeigneten Hartholzes oder mit Kreosot getränkten Kiefernholzes. Die Pfosten sind 4 bis 6 Zoll dick und 20 Fuß hoch. Die Endpfosten müssen wenigstens 6 × 6 Zoll stark sein, während für die inneren Pfosten etwas dünnere Stangen dienen können. Die Pfosten werden 1½ bis 2 Fuß tief in den Boden gesetzt, die inneren senkrecht, die äußeren etwas nach außen geneigt. Etwa 14 Fuß außerhalb von dem Fuße des Endpfostens jeder Reihe wird ein aus einem 6 × 6 Zoll dicken und 4 Fuß langen Holz bestehender „Anker" 4 bis 6 Fuß tief, je nach der Zähigkeit des Bodens, eingegraben. Für diese „Anker" zieht man das Holz der gemeinen Akazie vor wegen der Dauerhaftigkeit des Holzes. Ein starkes Drahtseil wird von der Spitze des Pfostens gezogen und an den „Anker" befestigt, oder aber man setzt nur den Draht über die Spitze des Pfostens fort bis an den „Anker". Um den Zutritt zu dem Felde zu erleichtern, setzt man oft die Pfosten nur an den Enden abwechselnder Reihen. In diesem Falle zieht man entweder den Draht in den Reihen ohne Endpfosten über den Enddraht hinüber und verankert ihn im Boden, oder man spaltet ihn oder befestigt ihn an den Endpfosten zu beiden Seiten. Für die Haupt- oder Kreuzdrähte, welche der Breite nach, d. h. den kürzeren Weg über das Feld hinweggehen und oben auf jedem Pfosten mit starken Oesen befestigt sind, nimmt man Nr. 0 geglühten Eisendraht. Diese Drähte werden fest angezogen und an beiden Enden an „Ankern" befestigt. Für die anderen oder Längsdrähte kann man Nr. 6 bis Nr. 8 geglühten Eisendraht nehmen. Bei den neuesten verbesserten Senkdrahtgerüsten werden die Längsdrähte unterhalb der Querdrähte mittels kurzer S-Haken aus Draht Nr. 2 gehalten. Bei der Pflücke kann man die Längsdrähte loshaken und herablassen, sodaß die Pflücker sie mühelos erreichen können. Dieses Gerüst kann meist zu einem Preise von 80 bis 90 Dollar für den Acre errichtet werden, und die Auslage für Stränge zum Aufbinden der Ranken beläuft sich auf etwa 5 Dollar für den Acre für das Jahr.

Bei einer anderen erfolgreichen Form dieses Systems läuft ein dritter, sogenannter „Brustdraht" über jede Reihe unterhalb und parallel mit dem Längsdraht in einer Höhe von 6 Fuß über der Erde hin. Die Stränge werden senkrecht nach dem Brustdraht gezogen und von dort aus schräg nach dem oberen oder Längsdrahte oberhalb der nächsten Hügelreihe. Der Winkel dieser schrägen Stränge ist durch die Entfernung zwischen den Reihen und die Höhe des Brustdrahtes bedingt. Je schroffer der Winkel, desto besser erwächst die Ranke. Bei einem halben rechten Winkel ist Ziehen mit der Hand erforderlich, während ein flacherer Winkel der Pflanze bessere Bestrahlung durch die Sonne verschafft und die Produktivität erhöht.

Das niedrige Gerüst.

Die niedrige Gerüstform tritt in verschiedenen Modifikationen auf. In einer Form werden etwa acht Fuß lange Stangen bei jedem Hügel aufgestellt. Ueber die Stangen hinweg laufen die ganze Länge und Breite der Pflanzung rechtwinklig sich kreuzende Drähte. Die Ranken werden an den Stangen emporgeleitet und halten sich dann an den Drähten. In manchen Fällen werden starke Stränge statt der Drähte benützt und vereinzelt die Stangen nur bei jedem dritten Hügel angebracht. Außer in solchen Lagen, welche starken Winden ausgesetzt sind, ist das hohe Gerüst weitaus befriedigender. Es ist eine dauernde Konstruktion, welche den Pferden und Wagen leichten Zutritt zu allen Teilen des Feldes gestattet. Die Hopfen erhalten gleichmäßiger Luft und Licht und entwickeln sich daher besser. Die Bodenbearbeitung wird weniger als bei dem niedrigen Gerüst durch herabhängende Zweige gestört. Die Hopfen lassen sich leicht, selbst noch bei der Pflücke, wo die schlimmsten Angriffe von Läusen vorkommen, waschen. Da die Hopfenranke einer horizontalen Stütze nicht folgt, so muß sie, wenn sie den Draht oder Strang des niedrigen Gerüstes erreicht, mit der Hand gezogen werden, was die Arbeitskosten bedeutend erhöht.

Das Befestigen der Stränge.

Bei Verwendung des Hochdrahtsystems bedient man sich baumwollener Stränge, um die Ranken zu halten, bis sie die Drähte erreichen. Der Strang besteht aus zwei zusammengeknoteten Stücken; das eine, 4 Fuß lang, mit einer Tragkraft bis zu 80 Pfund, wird an dem Draht befestigt, und das andere, 15 Fuß lang, mit einer Tragkraft bis zu 20 Pfund, wird an einen kleinen in den Hügel gesteckten Pflock gebunden. Der dünnere Strang ist stark genug, um die Ranke zu halten, bis sie den dickeren Strang oberhalb erreicht. Für den oberen Strick wird vielfach guter Hanf anstatt Baumwolle verwendet. Der Strang kann an dem Draht vermittels eines eigenen Knotapparates, der am Ende einer langen Stange angebracht ist, befestigt werden, doch pflegt man da, wo das Senkdrahtsystem besteht, einfach den Draht, an dem der Strick befestigt wird, loszuzwicken und herabzulassen, sodaß dann die Stränge von den Arbeitern auf dem Boden stehend angeknotet werden können. Die vorher in der richtigen Länge abgeschnittenen und geknoteten Stricke werden an dem Draht etwa 20 Zoll von dem genau über dem Mittelpunkte des Hügels befindlichen Punkte befestigt. In der Regel gebraucht man nur zwei Stricke für jeden Hügel, und wenn alle an dem Draht befestigt sind, wird der Draht wieder an seinem Platz an den Querdrähten angehakt.

Ein anderes Verfahren besteht in der Verwendung eines Wagens, auf welchem eine „Plattform" in geeigneter Höhe angebracht ist, daß die Arbeiter sich frei bewegen und die Stränge anknoten können. Der Wagen folgt dem Draht entlang über das Feld. Zwei oder drei Arbeiter auf dem Wagen knoten die Stränge so schnell, als die Pferde gehen können. Vier dem Wagen folgende Arbeiter befestigen die Stränge an den in jedem Hügel stehenden Pflöcken.

In den Stangengärten in New-York steckt man eine Oese in dem Ende des Strickes über die Spitze der Stange mit Hilfe eines Gabelstockes, zieht den Strick dann straff und befestigt ihn an der entsprechenden Stange in der nächsten Reihe etwa 5 Fuß über dem Erdboden. Häufig bringt man noch einen Strick von einer Stange zur andern in derselben Höhe über dem Boden an.

Das Ziehen der Ranken.

Wenn die jungen Ranken etwa 2 Fuß lang sind, so beginnt das Ziehen derselben. Gewöhnlich wählt man diejenigen vier in jedem Hügel, welche der Durchschnittslänge auf dem betreffenden Feld am nächsten kommen, und schneidet die übrigen ab. Bei ungleichförmigem Stande findet man es oft vorteilhaft, das ganze Feld abzuschneiden und auf den Nachwuchs der zweiten Ranken zu warten. Doch entwickeln sich anfangs schwach erscheinende Ranken später oft recht kräftig, nachdem sie eine Länge von 4 bis 5 Fuß erreicht haben. In allen schwach produzierenden Gegenden ist es in der Regel ratsam, die ersten Schößlinge aufzuziehen, während für stark produzierende Gegenden es rätlich erscheint, die zweiten Schößlinge zu ziehen. Man zieht meist zwei Schößlinge an je einem Strick und soll darauf achten, daß man sie von links nach rechts um denselben windet. In den New-Yorker Gärten zieht man an jeder Stange sieben Ranken, drei für den langen Strick und je zwei für den andern Strick und die Stange selbst.

Die Zeit für die Pflücke.

Die Pflückezeit ist je nach Oertlichkeit, Charakter des Jahres und Varietät der Pflanze verschieden. Bei ausgedehnten Pflanzungen ist man geneigt, mit der Pflücke zu beginnen, ehe der Hopfen ganz reif ist, da man sonst leicht einen Teil durch Ueberreife verlieren könnte. Vielfach spielt auch die Notwendigkeit, die Arbeiter früh zu gewinnen, eine große Rolle. Zu diesem Zwecke pflegt man in manchen Gegenden eine frühreife Varietät, die ... „Fuggles", zu bauen, welche acht bis zehn Tage früher reift als ... Sorten und es möglich macht, mit der Pflücke früher zu beginnen.

Zweitens ist auf die Leistungsfähigkeit der Hopfendarre Rücksicht zu nehmen, um den Hopfen flott nach der Pflücke darren zu können. Bei ausgedehnter Pflanzung und reicher Ernte wird die Leistungsfähigkeit der Einrichtungen zum Darren und Behandeln des Hopfens bis aufs äußerste in Anspruch genommen, und wenn mehr Hopfen gepflückt wird, als ohne ... gedarrt werden kann, so erwärmt sich derselbe und büßt seine Qualität teilweise oder ganz ein. Ungenügende Einrichtungen veranlassen den Pflanzer oft, mit der Ernte zu beginnen, ehe der Hopfen reif ist, ... fortzufahren, nachdem derselbe den geeignetsten Zeitpunkt überschritten ...

Ein dritter maßgebender Umstand, auf welchen jeder fortschrittliche Pflanzer achtet, ist der Einfluß der Pflückezeit auf die Qualität des Produkts. Die Entwicklung des ätherischen Oeles, der wünschenswerten Weichharze ... anderer wertvollen Bestandteile erreicht ihren Höhepunkt ungefähr ... der Vollreife des Hopfens, und in diesem Zustande gilt der Hopfen allgemein für am reichsten an Aroma. Vom Standpunkte des Konsumenten betrachtet, ist die Zeit der Pflücke von großem Interesse und sollte es auch für den Pflanzer sein, denn bei rechtzeitigem Pflücken ergibt sich ein bedeutend qualitätreicheres Produkt. Aus den angegebenen Gründen ist es jedoch sehr schwer, Arbeiter zu bekommen, wenn die Ernte gerade reif ist ... erwähnten Schwierigkeiten kommt noch der Umstand, daß die verschiedenen Pflanzen eines und desselben Feldes selten genau zugleich reif werden ... das Feld auch ganz horizontal, so bringen geringe Abweichungen in der Bodenbeschaffenheit oder dem Feuchtigkeitsgehalt doch leicht ungleichmäßiges Reifen hervor, und wenn man auch die Regel befolgt, in dem Felde ... zuarbeiten und die reifen Stellen auszusuchen, so ist doch selten möglich, die gesamte Ernte genau im Zeitpunkte des besten Reifegrades einzubringen. Obgleich die Pflanzer im allgemeinen die Wichtigkeit des rechtzeitigen Pflückens anerkennen, so fehlt doch vielen die Erkenntnis der Nachteile, welche sich aus der Vernachlässigung dieses Zeitpunktes ergeben. Nicht richtig gepflückte Hopfen besitzen verschiedene schwerwiegende Fehler, welche ihren Marktwert herabsetzen.

Die Mängel unreifen Hopfens.

Unreifer Hopfen enthält mehr Wasser im Verhältnis zum Gewicht der Trockensubstanz als der reife; folglich ist beim Darren das Produkt geringer an Qualität, d. h. das Verhältnis des trockenen Hopfens zu dem auf die Darre geladenen frischen Hopfen ist geringer bei unreifem Hopfen. Ferner ist der unreife Hopfen schwieriger zu darren, vermutlich wegen des höheren Wassergehaltes und der Neigung, sich fest zusammenzulegen, sobald er ... wird, und schließlich hält sich solcher Hopfen beim Lagern nicht so gut. Da im unreifen Hopfen das Lupulin seine volle Entwicklung nicht erreicht hat, tritt beim Pflücken in diesem Zustande ein absoluter Gewichtsverlust ein. Das Aroma ist beim unreifen Hopfen nicht so gut entwickelt, und die Menge der Harze ist geringer. Es tritt also beim zu frühen Pflücken nicht allein ein Gewichtsverlust ein, sondern so gut wie alle die erwünschten Eigenschaften, auf denen der Wert des Hopfens beruht, sind in erheblich geringerem Maßstabe vorhanden.

Proben für die Reife des Hopfens.

Es gibt gewisse praktische Proben, mittels deren der Reifegrad des Hopfens und der Zeitpunkt der Pflücke ohne Mühe festgestellt werden kann. 1. Die Dolden, welche im Stadium des Wachstums schön grün gefärbt sind, gehen bei nahender Reife allmählich in ein gelbliches Grün über. Allerdings liefert dies keine exakte Probe, weil die Farbe mehr oder weniger von dem Boden und gewissen anderen Faktoren bestimmt wird. Gewisse Hopfen haben bei der Vollreife eine grünliche Farbe. In Feldern, in denen die wilde Winde stark wuchert, können die Dolden gelblich werden, ohne daß dieses ein Reifen andeutet, sondern vielmehr einen ungesunden Zustand der Pflanzen. 2. Unreife Hopfen sind weich und biegsam und besitzen keine Elastizität. Bei vorrückender Reife jedoch nimmt die Elastizität zu, und wenn man die Dolden mit den Fingern zusammendrückt, so springen sie, sobald man sie losläßt, wieder in ihre ursprüngliche Gestalt zurück. 3. Wenn der Hopfen sich bröcklig anfühlt und beim Drücken in der Hand ein raschelndes Geräusch macht, so gilt er für reif. 4. Die sogenannten Samen des Hopfens sind eigentlich Früchte; der Samen ist von einer dicht anschließenden Haut umgeben, welche zur Zeit der Reife dunkel weinfarbig erscheint. Um diese Zeit füllen sich die Samen und werden hart. 5. Die Deckblätter an der Spitze der Dolde schließen sich bei fortschreitender Reife, und die Dolden selbst fühlen sich klebrig oder fettig an. 6. Unreifer Hopfen besitzt nur wenig Geruch außer dem natürlichen grünen oder Pflanzengeruch, und der charakteristische Lupulingeruch tritt erst mit nahender Reife und dann in sehr markanter Weise auf. 7. Bei herannahender Reife gehen die oberen Blätter der Pflanze von Hell- in Dunkelgrün über, während die Blätter am unteren Teile der Pflanze gelb werden und abfallen.

Der Zweck des Darrens.

Der Hauptzweck des Darrens ist, den Feuchtigkeitsgehalt schnell so weit herabzusetzen, daß der Hopfen ohne Gefahr gelagert werden kann, ohne seine Eigenschaften zu verlieren. Es ist notwendig, den Hopfen kurz nach dem Pflücken zu darren, sonst tritt ein Oxydationsprozeß oder ein Erwärmen ein, welche das Aussehen, sowie das Aroma und andere wertvollen Eigenschaften erheblich beeinträchtigen. Je nach der Varietät und dem Reifegrade bei der Pflücke enthält frisch gepflückter Hopfen 65 bis 75 % Feuchtigkeit, soll aber im gedarrten Zustande, wenn er lager- oder marktreif ist, nur 10 bis 14 % enthalten. Eingehendere Kenntnis der Bestandteile und Eigenschaften des Hopfens hat dazu geführt, das Darren so zu führen, daß der Hopfen nicht allein schön aussieht, sondern auch die größtmögliche Menge der erwünschten Stoffe, auf denen der eigentliche Wert beruht, enthält. Die wichtigsten dieser Stoffe sind das zum größten Teil in den Deckblättern der Dolde vorkommende

Tannin, die Weichharze, das flüchtige Oel und die hauptsächlich im Lupulin aufgespeicherten Bitterstoffe. Nur zu oft wird das Darren ausschließlich im Hinblick auf das Aussehen allein geführt, und die dabei angewendeten Methoden beeinträchtigen oft die Qualität des Hopfens durch ihren nachteiligen Einfluß auf das Oel, das Lupulin usw.

Die Theorie des Darrens.

In der Entfernung der Feuchtigkeit aus dem Hopfen besteht das Darren. In der Luft geschieht dies gewöhnlich durch Verdampfung, ein Prozeß, der von der Fähigkeit der die trocknenden Hopfen umgebenden Luft, die Feuchtigkeit an der Oberfläche in dampfförmigem Zustande fortzutragen, abhängt. Die Feuchtigkeitsmenge in Gestalt von Dunst, welche die Luft aufnehmen kann, ist durch den Trockenheitsgrad der letzteren bedingt, denn die Luft kann nur ein gewisses Maximum Dunst aufnehmen. Wenn dieses Maximum erreicht ist, so ist die Luft gesättigt oder auf dem Taupunkt und kann keine Feuchtigkeit mehr aufnehmen. Um den Trockenprozeß fortzusetzen, muß die gesättigte Luft fortwährend durch trocknere Luft ersetzt werden, und eine lebhafte künstliche Zirkulation beschleunigt daher den Vorgang. Die Fähigkeit der Luft, Feuchtigkeit aufzunehmen, ändert sich je nach der Temperatur, und eine unmittelbare Wirkung der Wärme auf die Atmosphäre besteht in der Erhöhung ihrer Fähigkeit, Wasserdunst aufzunehmen. Es ist z. B. festgestellt worden, daß die Feuchtigkeit in 10000 Kubikfuß mit Wasserdunst gesättigter Luft bei 62 Grad F. (17 Grad C.) 8.81 Pfund wiegt. Wird die Temperatur der Luft auf 82 Grad F. (28 Grad C.) erhöht, so können die 10000 Kubikfuß Luft 7.86 Pfund mehr Feuchtigkeit aufnehmen, und bei Erhöhung der Temperatur auf 122 Grad F. (50 Grad C.) kann die Luft weitere 42.61 Pfund aufnehmen. Ist jedoch die Luft bei 62 Grad F. (17 Grad C.) nur halb gesättigt, so enthalten 10000 Kubikfuß nur 4.4 Pfund Feuchtigkeit; wird dann die Temperatur auf 82 Grad F. (28 Grad C.) gebracht, so können die 10000 Kubikfuß 12.27 Pfund mehr aufnehmen, und die Erhöhung auf 122 Grad F. (50 Grad C.) gestattet die Aufnahme von 47 Pfund mehr. Das zum Trocknen in einem gewissen Zeitraum erforderliche Volumen Luft ist von der Temperatur derselben bedingt. Wegen der größeren Fähigkeit, Feuchtigkeit anzunehmen, kann ein kleines Volumen Luft von hoher Temperatur ein Quantum Dunst aufnehmen und fortführen, dessen Entfernung ein verhältnismäßig großes Volumen Luft von niedriger Temperatur erfordern würde. Wenn halb gesättigte Luft, auf 162 Grad F. (72 Grad C.) erwärmt, über eine feuchte Oberfläche mit einer Geschwindigkeit von 10000 Kubikfuß in der Minute hinstreicht und dabei in diesem Zeitraume 130 Pfund Feuchtigkeit fortführt, so würden ungefähr 23 Minuten erforderlich sein, um 3000 Pfund Feuchtigkeit zu entfernen. Wird dieselbe Luft auf 82 Grad F. (28 Grad C.) gekühlt, so können 10000 Kubikfuß in der Minute ungefähr 12 Pfund entfernen, und es würden nahezu 4½ Stunden erforderlich sein, um 3000 Pfund Feuchtigkeit zu entfernen. Um die Feuchtigkeit in der gleichen Zeit zu entfernen wie die Luft bei 162 Grad F. (72 Grad C.), würde ein Volumen von annähernd 108000 Kubikfuß in der Minute erforderlich sein. In der Praxis hat man gefunden, daß die Luft beim Durchstreichen eines Haufens Hopfen nicht vollständig mit Feuchtigkeit gesättigt wird und nur in den Anfangsstadien des Darrprozesses die tatsächlich entfernte Feuchtigkeitsmenge der Quantität, welche entfernt werden würde, falls die Luft vollkommen gesättigt würde, nahekommt. Bei den gewöhnlich in den Darren herrschenden Temperaturen ist es daher zur Entfernung einer gegebenen Menge Feuchtigkeit notwendig, ein viel größeres Volumen Luft zu beschaffen, als nach den eben angegebenen Zahlen erforderlich zu sein scheint. Ein gewisser Wärmegrad ist beim Hopfendarren immer vorteilhaft wegen der Bedingungen, unter denen die Feuchtigkeit im Hopfen vorhanden ist. Ein Teil dieser Feuchtigkeit besteht in freiem Wasser und wird beim Darren zuerst erschöpft. Der Rest bildet einen Teil des Saftes und der Gewebe der Pflanze, und das Entfernen dieses Teiles beeinflußt den physikalischen Zustand des trocknenden Hopfens. Durch die Erhöhung der Temperatur in den Geweben und dem Zellensaft befördert die Wärme das Aufsteigen des Wassers an die Oberfläche, wo es durch Verdunstung entfernt werden kann. Ferner ist künstliche Erwärmung notwendig, um die durch den Verdunstungsprozeß dem Hopfen entzogene Wärme zu ersetzen, sonst bleibt die Temperatur der in den Zellen gehaltenen Feuchtigkeit so niedrig, daß sie nicht leicht an die Oberfläche steigt, und das Darren wird dadurch verzögert.

Beim Hopfendarren werden günstige Resultate nicht allein durch die Zufuhr großer Wärme unter der Darrhorde erzielt. Wenn Hopfen 14 bis 30 Zoll hoch auf der Darre aufgeschichtet sind, so bilden sie einen äußerst schlechten Wärmeleiter. Und zwar sind nicht allein die Hopfen selbst ein schlechter Leiter, sondern die mit Wasserdunst geschwängerte Luft, welche die Räume zwischen den Hopfen anfüllt, bietet der Wärmeübertragung starken Widerstand. So kommt es, daß, wenn die untere Lage der Hopfen erwärmt wird, die Feuchtigkeit aus derselben getrieben, die damit in Berührung kommende Luft mit derselben gesättigt wird und schnell emporsteigt, um mit den kühleren Schichten in Berührung zu kommen. Hier wird die gesättigte Luft abgekühlt, die Feuchtigkeit in derselben kondensiert sich und setzt sich auf den oberen Hopfenschichten ab, sodaß diese naß werden. Bei fortgesetzter Erwärmung werden die unteren Schichten ausgetrocknet und zu stark erwärmt, während die langsam durch die Schichten empordringende Wärme die oberen, nassen Schichten sozusagen schmort. Die Sache wird oft noch verschlimmert durch das Wenden des Hopfens, weil dadurch die zu stark getrockneten unteren Schichten obenauf kommen und wieder gedämpft und nochmals getrocknet werden. Es ist selbstverständlich wünschenswert, die Feuchtigkeit schnell und kontinuierlich auszutreiben, und dazu sind Zug und Ventilation notwendig. Ein starker Zug ist erforderlich, damit die erwärmte Luft schnell durch den Hopfen hindurchstreicht, weil bei schnellem Wechsel der mit dem feuchten Hopfen in Berührung kommenden Luft keine Zeit zur annähernden Sättigung vorhanden ist und die Luft daher in den oberen Schichten ziemlich scharf gekühlt werden kann, ohne den Taupunkt zu erreichen und die Feuchtigkeit zum Niederschlag kommen zu lassen. Ventilation oberhalb der Hopfenschicht ist notwendig zur Entfernung der dunstgeladenen Luft, sonst würde der Taupunkt schnell erreicht werden und die Feuchtigkeit sich an den Wänden, sowie an den Hopfen selbst niederschlagen. Die Ventilation hängt mit dem Luftzug eng zusammen; Verhältnisse, welche einen guten natürlichen Zug hervorbringen, bedingen auch genügende Ventilation.

Luftzug und Ventilation, sowie das Trocknen selbst hängen stark von der Temperatur und Feuchtigkeit der Atmosphäre ab. Zug oder eine entschiedene Bewegung der Luft nach oben in einer Darre tritt ein, wenn unten Wärme zugeführt wird. Die kalte Luft außerhalb der Darre sucht vermöge ihrer größeren Schwere kontinuierlich einen Ausgleich des Druckes und strömt daher nach dem Boden der erwärmten Darre. Die erwärmte Luft wird dadurch emporgetrieben, und die an ihre Stelle strömende kalte Luft wird erwärmt und steigt ebenfalls empor. So tritt ein kontinuierlicher Kreislauf ein, dessen Schnelligkeit und Volumen von dem Unterschied in der Dichte der Luft außerhalb und innerhalb der Darre bedingt wird.

Die Temperaturwechsel in der äußeren Luft haben einen ausgesprochenen Einfluß auf den Zug. Beim Hopfendarren hat man beobachtet, daß der beste Luftzug in der Regel etwa um 2 oder 3 Uhr morgens eintritt, d. h. um die Zeit, wo der Unterschied zwischen der äußeren und der inneren Luft am größten ist, bei entsprechendem Unterschied im Druck und folglich zunehmendem Zuge. Dieser Vorteil wird jedoch zum großen Teil durch die weitaus größere Feuchtigkeit in der Luft während der Nacht ausgeglichen. Am Tage, wo die Temperatur in der Luft hoch ist, wird es oft schwer, genügend Luftzug zu schaffen, ohne den Hopfen zu stark zu erwärmen. Ein Unterschied von 50 Grad F. (10 Grad C.) zwischen der Temperatur unter der Darrhorde und derjenigen oberhalb der Darre gilt in Kalifornien für notwendig, um genügenden Druck zu erhalten, um die Luft durch den Hopfen zu ziehen. In Oregon ist in der Regel eine Differenz von 30 Grad F. (— 1 Grad C.) genügend, um dasselbe Resultat zu erzielen, und zwar weil man hier den Hopfen nicht so hoch auf der Darre schichtet, und ferner 20 bis 24 Stunden darrt, gegen 10 bis 20 Stunden in einigen Gegenden in Kalifornien. In der Annahme, daß eine Differenz von 30 bis 50 Grad F. (— 1 bis + 10 Grad C.) zwischen der Atmosphäre und der Luft in der Darre erforderlich ist, um einen Luftzug durch den Hopfen herzustellen, liegt es auf der Hand, daß die größte Sorgfalt notwendig ist, um eine Schädigung des Hopfens durch zu starkes Erwärmen zu vermeiden. Viele Schwierigkeiten, welche der Verwendung des natürlichen Luftzuges anhaften, hat man durch Einführung künstlichen Zuges zu überwinden gesucht. Man forciert ein großes Volumen Luft durch den Hopfen hindurch, schafft damit sofort einen guten Luftkreislauf und läßt die Feuchtigkeit entweichen, sodaß der Hopfen nicht dem langen Schwitzen und Dämpfen ausgesetzt wird, welches bei natürlichem Luftzuge unvermeidlich ist. Auch kann man bei viel niedrigerer Temperatur darren, und dieses Verfahren bietet viele andere Vorteile, darunter absolute Kontrolle einer niedrigen, gleichförmigen Temperatur, wodurch der Hopfen an Weichharzen, Geschmack, Aroma und Gewicht gewinnt.

Die Vorgänge beim Darren.

Wenn der Hopfen auf die Darre geladen wird, so sind die Gewebezellen noch am Leben. Das rationelle Darren soll diese Zellen abtöten dadurch, daß ihnen allmählich und bei mäßiger Temperatur das Wasser entzogen wird. Innerhalb einer jeden Zelle befinden sich viele chemische Stoffe, welche getrennt bleiben, solange die Zelle lebendig ist, jedoch dadurch, daß der Zelle das Wasser entzogen wird, außer Lösung treten und in sehr leicht löslicher Form zurückbleiben. Wenn die Entziehung des Wassers nicht kontinuierlich vor sich geht oder die Dünste sich niederschlagen, so setzt sich Feuchtigkeit auf dem Hopfen ab, wird wieder absorbiert, kommt mit den leicht löslichen Stoffen in Berührung und löst dieselben auf. In diesem Zustande führen diese Stoffe zum Schwärzen oder Entfärben, sowie zu anderen Schädigungen des Hopfens. Die Zellen können ohne starken Wasserverlust dadurch abgetötet werden, daß man sie plötzlich einer hohen Temperatur aussetzt. In diesem Falle bleiben die chemischen Stoffe nicht getrennt, sondern fließen zusammen und bilden neue Stoffe, welche Veränderungen in Farbe, Aroma und anderen erwünschten Eigenschaften veranlassen. Die Zellen können einen beträchtlichen Wasserverlust ertragen, ehe sie sterben, wenn die Temperatur unterhalb eines gewissen Punktes (ungefähr 110 Grad F. — 43 Grad C.) bleibt. Sobald der Tod einer Zelle eintritt und die Bestandteile anfangen, zusammenzufließen, soll man das Darren mehr forcieren, um die vorhandene Wassermenge so schnell wie möglich zu vermindern, aber selbst in diesem Stadium kann man die Temperatur doch wohl nicht lange über 140 Grad F. (60 Grad C.) halten, ohne das Produkt zu schädigen. (Schluß folgt.)

Kleine Mitteilungen.

Bierbrauerei im Handelskammerbezirke Gießen. Im Jahresberichte der Handelskammer Gießen für das Wirtschaftsjahr 1907 findet sich über die Lage der Brauindustrie im Berichtsjahre folgendes: Das Jahr 1907 eröffnete mit schleppendem Geschäftsgange. Mit dem Frühjahre besserte sich derselbe einigermaßen, doch blieb infolge der kühlen Sommerwitterung der Umsatz gegen das Vorjahr zurück. Auch die Abschaffung der Fünfzehntelliter-Gläser seitens vieler Wirte trug erheblich zum Minderabsatze bei. Das Eis konnte günstig eingebracht werden. Für die Rohmaterialien (Gerste und Hopfen) mußten höhere Preise angelegt werden. Die bereits sehr hohen Kohlenpreise erfuhren mit dem 1. April eine weitere Steigerung, und dasselbe gilt von den Arbeitslöhnen. Auch für Futterartikel und Pferdeankäufe mußten erheblich größere Ausgaben gemacht werden, und durch alle diese Umstände wurde der Verdienst sehr beeinträchtigt. Ueber die Biererzeugung im Bezirke der Handelskammer während der letzten fünf Jahre gibt folgende Tabelle Aufschluß:

Rechnungsjahr	Am Schlusse des Jahres vorhandene Brauereien		Im Laufe des Jahres im Betriebe befindliche gewerbliche Brauereien			Menge des gewonnenen Bieres (Hektoliter)	
	in den Städten	auf dem Lande	fixierte	Vermahlungssteuer entrichtende	auf Brauanzeige steuernde	obergäriges	untergäriges
1903	13	4	2	—	11	—	170252
1904	13	3	2	—	11	—	181642
1905	10	5	—	—	12	—	175121
1906	12	—	—	—	12	—	175959
1906/07	12	—	—	2	10	—	176907

Bierbrauerei und Mälzerei im Handelskammerbezirke Liegnitz. Der Jahresbericht der Liegnitzer Handelskammer für das Jahr 1907 schreibt über das Braugewerbe: Die ungünstige, kalte Witterung im Frühjahr und Sommer schwächte den Verbrauch sehr erheblich. Ebenso traten für den Bierbrauereibetrieb die Einwirkungen der durch die Zollgesetzgebung geschaffenen Steigerungen für Braumaterialien und die Höhe der Arbeitslöhne benachteiligend hervor. Als dann von August an sich der Bierverbrauch etwas hob, streikten bei drei hiesigen Brauereien unversehens die Brauer und Arbeiter, weil ihnen die geforderten Lohnerhöhungen und günstigeren Arbeitsbedingungen nicht sofort gewährleistet wurden. Der Streik endete zum Nachteile der Ausständigen, weil die Brauereien an deren Stelle andere Kräfte erhielten. Man darf somit wohl sagen, daß die Brauereien keinen leichten Stand hatten, obwohl die wirtschaftliche Konjunktur im allgemeinen keine ungünstige war. Von 31 Brauereien wurden hergestellt: obergäriges (Einfach-, Doppel-, Weizen-)Bier 41096.10 Hl., untergäriges (Lager-)Bier 103950.50 Hl., zusammen 145046.60 Hl. Dazu wurden verwendet: Gerstenmalzschrot 1915644.50 Kilo, Bierkulör und Zucker 68850 Kilo, zusammen 1984494.50 Kilo. An Brausteuer kamen dafür 110275.30 M. zur Erhebung. An Biersteuer entrichteten: bis 150 M. 11 Brauereien, über 150 bis 300 M. 1, über 300 bis 600 M. 4, über 600 bis 1200 M. 3, über 1200 bis 1500 M. 2, über 1500 M. 10 Brauereien. Ueber Mälzerei gibt der Jahresbericht folgende Mitteilung: Das Malzfabrikationsgeschäft litt ganz bedeutend unter der Ungunst der Verhältnisse. Die zu Anfang der neuen Kampagne im Herbst 1907 einsetzenden enorm hohen Gerstenpreise, wie solche fast noch nie vorher dagewesen sind, übten einen ungünstigen Einfluß auf die neue Malzkampagne aus, und der Umstand, daß die Brauereien fast alle noch reichlichen Vorrat an Malz in ihr neues Geschäftsjahr mithin hernahmen, erschwerten den Absatz zu gewinnbringenden Preisen.

Die Kundgebung der englischen Hopfenpflanzer. Die Kundgebung der Hopfenbauern und Landarbeiter aus Kent und Sussex, die am 15. d. Mts. mit Frauen und Kindern nach dem Trafalgar Square in London wallfahrteten, um von der Regierung einen Hopfenzoll von mindestens 2 Guineen zu verlangen, und über welche wir bereits kurz in unserer Nr. 116 berichteten, ist, so wird der „Voss. Ztg." geschrieben, eine von den Geschichten,

Nr. 132. Nürnberg. Allgemeine Samstag, 6. Juni 1908. 24

Brauer- und Hopfen-Zeitung.

Offizielles Organ des Deutschen Brauerbundes,
des Bayerischen Brauerbundes, der Vereinigung Süddeutscher Malzfabriken, des Thüringer Brauervereins, des Vereins der Brauereien des Leipziger Bezirks, sowie des Deutschen Braumeister- und Malzmeister-Bundes.
Publikations-Organ sämtlicher Sektionen der Brauerei- und Mälzerei-Berufsgenossenschaft, sowie des Boykottschutzverbandes Deutscher Brauereien.
Eigenes Brautechnisches Laboratorium.

Erscheint täglich, Sonn- und Feiertage ausgenommen. Im Deutschen Reiche, in Oesterreich-Ungarn, in der Schweiz und in Luxemburg sind Bestellungen ausschließlich bei den amtlichen Poststellen anzubringen. Der Bezugspreis beträgt vierteljährig 6 M. Außerdem werden Bestellungen auf dem amtlichen Zeitungspostwege in Belgien, Holland, Dänemark, Schweden, Norwegen und Italien angenommen. Von der Geschäftsstelle in Nürnberg direkt kann das Blatt nur nach dem Auslande und nur auf ganzjährige Dauer bezogen werden. Bezugspreis für den Weltpostverein mit wöchentlich dreimaligem Versand 29 M. = 36 Fr. 25 Cts., mit täglichem Versand 36 M. = 45 Fr. Telegramm-Adresse: Hopfenzeitung Nürnberg. Fernsprech-Nr. 1348.

XXXXVIII. Jahrgang.

Anzeigen werden mit 25 Pfg. für die fünfgespaltene Petitzeile 5 Zm. breit oder deren Raum berechnet. [illegible] Gesuchsstelle werden [illegible] Beilagen [illegible] Geschäftsstelle in Nürnberg. Manuskripte werden nicht zurückgegeben.

Hopfenbau und Hopfendarren in den Vereinigten Staaten.

II. (Schluß.)

Von W. W. Stockberger, Sachverständiger in Drogenpflanzen-Untersuchungen, Büreau für Pflanzen-Industrie, Vereinigte-Staaten-Departement für Landwirtschaft. (Aus „American Brewers' Review" 1907, Nr. 11 und 12 und 1908 Nr. 1, 2 und 4.)

Die Praxis des Darrens.

Der wichtigste und zugleich schwierigste Punkt bei der ganzen Hopfenproduktion ist das richtige Darren. Kein anderer Faktor beeinflußt in gleichem Maße die Qualität, das Aussehen und den Marktpreis wie die Methode, nach welcher der Hopfen während des Trockenprozesses behandelt wird. Beim Darren sind drei Faktoren von ausschlaggebender Wichtigkeit. Nämlich 1. der angewandte Temperaturgrad, 2. die Dauer des Darrprozesses, 3. die durch den Hopfen durchgehende Luftmenge. Außerdem ist auch dann, wenn man das Darren bei einem sehr niedrigen Wärmegrade vornimmt, die Feuchtigkeit der Luft ein wichtiger Faktor. Von den erwähnten Faktoren sind nur die beiden ersten allgemein anerkannt, und wenn man jetzt hohe Wärmegrade benützt, so ist dieses das Ergebnis des Bestrebens, die Darrzeit abzukürzen. Es ist aber möglich, die Temperatur wesentlich herabzusetzen, ohne die Darrzeit zu verlängern, indem man nämlich durch den Hopfen eine große Luftmenge von niederer Temperatur hindurchstreichen läßt. Zuerst muß man darauf sehen, daß der Hopfen in richtiger Weise auf die Darrhorde geladen wird. Er soll gleichmäßig und lose in einer Schicht von 14 bis 24 Zoll ausgebreitet werden, je nach der Reife. Bei ungleichmäßigem Laden der Darre dringt die Hitze zuerst an den dünneren Stellen durch, und diese trocknen früher, während die tieferen Stellen feucht bleiben. Ist der Hopfen fest getreten oder in anderer Weise fest auf den Boden gepackt, so kann die Hitze nicht leicht durchdringen, und das Darren wird dadurch ungleichmäßig. Einige praktische Hopfenbauer befestigen ein starkes Drahtnetz von ungefähr fünf Zoll Maschenweite in der gewünschten Höhe über der Horde, durch das der aus den Säcken geschüttete Hopfen leicht und gleichmäßig auf die Horde herunter fällt. Die Oberfläche wird dann sorgfältig mit einem Rechen geebnet. Sobald die Darre geladen ist, werden die Feuer geöffnet, und die Hitze wird allmählich auf den erwünschten Punkt gebracht. Nach drei bis fünf Stunden ist der Hopfen durch und durch erhitzt, und es ist auch genügend Feuchtigkeit entfernt, sodaß die heiße Luft mit Leichtigkeit durchdringen kann. Bis dieser Punkt erreicht ist, muß man auf die Temperatur scharf acht geben, da die unteren Schichten versengt werden würden, wenn man von allem Anfange an zu schnell feuerte. In den Gegenden, in denen man das Trocknen in zehn bis zwölf Stunden beendet, ist es üblich, den Hopfen mit einer hölzernen Gabel, wie man sie für die Gerste benützt, umzuwenden, wenn die unteren Schichten trocken genug sind, daß sie rascheln, wenn man in ihnen herumrührt. Das sollte aber nur getan werden, wenn es sich als unumgänglich notwendig erweist, da das Umwenden den Hopfen bricht und zerpflückt und ein Teil des Lupulins verloren geht. Auch macht dieses Vorgehen ein gleichmäßiges Trocknen unmöglich, weil ja der Hopfen nicht gleichmäßig gewendet werden kann. Während des Verlaufes des Darrprozesses muß für genügende Ventilation gesorgt werden, damit die Feuchtigkeit entfernt werden kann, wobei aber die Seiten der Darre und die Oberschicht des Hopfens nicht so stark abgekühlt werden dürfen, daß die Feuchtigkeit sich wieder niederschlägt. Erwärmt man die Luft und die Seiten der Darre oberhalb des Hopfens, so erleichtert dieses das Trocknen ganz wesentlich. In den mehr nördlich gelegenen Hopfengegenden haben die erfolgreichsten Hopfendarren ein Dach, wodurch die Hitze besser zurückgehalten wird. Die Tatsache, daß man fast allgemein die nachträgliche Wirkung einer großen Hitze beim Darren nicht erkennt, hat in der Praxis sehr weit voneinander verschiedene Methoden veranlaßt. Temperaturen von über 200 Grad F. (93 Grad C.) sind gar nichts Ungewöhnliches. Daß eine solche Temperatur aber viel zu hoch ist, ist durch Versuche erwiesen worden, die man mit Hopfen, der in verschiedenen Darren bei verschiedenen Temperaturen behandelt wurde, angestellt hat. Abgesehen davon, daß man das Aroma durch übermäßiges Ausdarren oder Versengen verdirbt, hat man auch einen ganz erheblichen Verlust an wertvollen flüchtigen Stoffen beim Darren bei hoher Temperatur zu verzeichnen. Das ätherische Oel, welchem das Aroma größtenteils entstammt, verdunstet teilweise, und das Lupulin wird minderwertig, da der Gehalt an den wünschenswerten Weichharzen im Verhältnis zu der Erhöhung der Darrtemperatur geringer wird. Die beste Darrtemperatur bleibt noch festzustellen, aber alle Gründe sprechen dafür, daß sie viel niedriger sein sollte als die, die wir gewöhnlich anwendeten, vermutlich zwischen 100 und 140 Grad F. (38 bis 60 Grad C.). Die praktische Erfahrung hat bewiesen, daß man mit einer Temperatur von 110 Grad F. (43 Grad C.) gut darren kann, und die Ansichten wenden sich im allgemeinen dem Gebrauch einer niedrigeren Temperatur beim Trocknen zu. Doch kann keine Temperatur als die geeignetste für die Darre allgemein normiert werden, weil ein Wärmegrad, der während des einen Stadiums des Darrprozesses wahrscheinlich schädlich sein würde, in einem anderen gar keine nachteilige Wirkung ausüben würde. Beim Messen der Temperatur muß man darauf sehen, daß das Thermometer dort angebracht wird, wo die auf den Hopfen wirkende Hitze die höchste ist, und man hat gefunden, daß dieser Punkt gerade unter der Darrhorde ist. Während des ersten Darrstadiums weist ein unter dem Tuche der Darrhorde angebrachtes Thermometer einen höheren Grad auf als eines, welches man auf der Horde selbst in der Grundschicht des Hopfens anbringt, und eines, welches gerade über dem Hopfen sich befindet, zeigt 30 bis 40 Grad weniger, bis der Trockenprozeß ungefähr halb fertig ist und die Hitze durch den Hopfen durchgedrungen ist. Während dieser Periode konzentriert sich nämlich die Hitze auf die unteren Hopfenschichten, und deshalb muß man da die größte Sorgfalt anwenden, um Schaden zu vermeiden. Wenn die Hitze durch den Hopfen durchzudringen beginnt, wird das obere Thermometer ein schnelles Steigen der Temperatur aufweisen, während dasjenige unter der Darrhorde fällt. Von diesem Zeitpunkt an aber werden dann bis zum Ende des Darrprozesses beide Thermometer ungefähr den gleichen Hitzegrad zeigen.

Hopfen wird, wie schon erwähnt, häufig in zehn bis zwölf Stunden getrocknet, doch muß bei sonst gleichen Bedingungen eine höhere Temperatur benützt werden, als wenn man die Zeit auf achtzehn bis zwanzig Stunden ausdehnt. Die Vorzüge des langsameren Darrens oder des Darrens bei niedrigerer Temperatur sollten von allen Hopfenbauern vollständig verstanden werden. Sogar eine mäßig hohe Temperatur schadigt, wenn zu lange angewendet, die Qualität des Hopfens ebenso wie eine zu hohe Temperatur. Um den Hopfen bei möglichst niedriger Temperatur darren zu können, muß man während des Darrens einen starken Luftzug unterhalten, der unaufhörlich die Feuchtigkeit von dem Hopfen fortführt. Zweifellos entspricht gegenwärtig die Darre mit Gebläse-Luftzug am besten diesen Anforderungen.

Es ist noch keine Norm festgesetzt worden, um zu entscheiden, wann der Hopfen genügend getrocknet ist. Nur erfahrungsgemäß kann man den Zeitpunkt feststellen, in welchem er ohne Gefahr aus der Darre entfernt werden kann. Das ganze Darrsystem ist eben von Tag zu Tag verschieden, weil es vom Wetter und von der Reife des Hopfens selbst abhängig ist. Im allgemeinen kann man sagen, daß das Trocknen fortzusetzen ist, bis alle Stengel oder Spindeln wohl zusammengeschrumpft, aber doch noch weich und biegsam sind. Die Stengel werden, sobald sie zu stark getrocknet sind, leicht brechen und sich zerkrümeln lassen, und das Lupulin verliert dann sein helles gelbes Aussehen und wird braun. Wenn der Hopfen von der Darre feucht oder nicht genügend gedörrt abgenommen wird, dann erhitzt er sich sehr leicht, wodurch das Lupulin braun wird, auch entwickelt er dann häufig einen sauren, dumpfen Geruch, der ihn nicht erwünscht erscheinen läßt. Wenn er dagegen zu lange oder zu stark getrocknet ist, dann bricht er leicht und wird spreuähnlich; auch entwickelt er einen brenzlichen Geruch. Die dünnen blätterartigen Teile des Hopfens werden gewöhnlich trocken genug, sodaß sie leicht brechen, sobald die Stengel hinreichend gedarrt sind, um den Hopfen ohne Gefahr aus der Darre entfernen zu können. Eine Abhilfe dafür kann man dadurch erzielen, daß man die Ventilatoren eine halbe Stunde vor der Beendigung des Darrens schließt. Dadurch wird auch bis zu einem gewissen Grade der Hopfen, der zu stark gedarrt ist, wieder verbessert, da die weitere Verflüchtigung der Feuchtigkeit aus der Darre verhindert wird, was dazu beiträgt, daß der Hopfen gleichmäßiger, weicher und zäher wird. Viele sorgfältige Darrer machen es sich zur Regel, die Ventilatoren mit dem Fortgange des Darrprozesses nach und nach schließen zu lassen und mit geschlossenen Ventilatoren abzudarren. Das gleiche Ergebnis erzielt man in weniger vollkommener Weise, wenn man alle Türen der Darre öffnet und den Hopfen ungefähr eine Stunde abkühlen läßt, da er auch auf diese Weise Feuchtigkeit aus der Luft in sich aufnimmt und weniger brüchig wird.

Das Schwefeln.

Das jetzt fast allgemein übliche Schwefeln des Hopfens ist auf die Nachfrage der Kunden nach den bläßlich gelbgrünen Sorten zurückzuführen. Die Verwendung von Schwefel gibt dem Hopfen nicht nur die erwünschte gelbe Farbe, sondern macht auch sein Aussehen gleichförmiger, wodurch seine Verkäuflichkeit erhöht wird. Viele Händler lassen sich mehr durch die Färbung als durch sonstige Eigenschaften beeinflussen, und es ist vorgekommen, daß solche Händler ungeschwefelten Hopfen für minderwertig abschätzten, während geschwefelter Hopfen, der von demselben Felde stammt, für sehr gut erklärt wurde.

Die Verwendung von Schwefel verbessert die Färbung durch einen Bleichprozeß, schwächt die vorhandenen Mikroorganismen, wodurch die Haltbarkeit wahrscheinlich erhöht wird, und beschleunigt, wenigstens nach einer weitverbreiteten Ansicht, das Darren. Gewöhnlich brennt man den Schwefel beim Beginn des Trocknens unter der Darrhorde ab. Dabei verwendet man meist zwischen 2 und 6 Pfund Schwefel auf je 100 Pfund ungetrockneten Hopfen. Die Einwirkung des Schwefels ist am stärksten, wenn der Hopfen noch frisch und feucht ist. Man darf aber nur raffinierten Schwefel, dessen Reinheit garantiert ist, benützen, da die groben Sorten gewöhnlich Verunreinigungen enthalten, die der Qualität des Hopfens schädlich sein könnten. Die besten Resultate bekommt man mit der im Handel als gesiebter Schwefel bekannten Sorte. Stangenschwefel unterscheidet sich von diesem nur in der Form, in die er gegossen ist, hat aber keine größere Bleichwirkung.

Es gibt viele verschiedene Darrkonstruktionen. [illegible] sind, welche Art Gebäude man auch zum Hopfentrocknen benützen mag, [illegible]

man dies schnell zustande bringen, so braucht man eine sehr große Luftmenge, wenn man die Temperatur unter dem Punkte hält, bei welchem die Güte des Hopfens zu leiden beginnt. Der Vorzug dieses Typus einer Darre mit einem Gebläseventilator von genügender Größe liegt darin, daß man durch den Hopfen eine große Luftmenge von niedriger Temperatur forcieren und die Feuchtigkeit entfernen und den Hopfen vollständig trocknen kann, ohne Gefahr zu laufen, den Hopfen übermäßig zu erhitzen oder zu versengen. Die gewöhnliche Ofendarre läßt sich mit Leichtigkeit in eine Luftgebläse-Darre umbauen, indem man einfach die Gebläse und die Vorrichtungen zur Erwärmung der Luft anbringt. Fig. 14 zeigt eine Gruppe von sechs Ofendarren, welche so umgebaut wurden, und zwar mit Unkosten, welche bedeutend niedriger waren als die für die Erbauung einer ganz neuen Anlage.

Die Behandlung im Kühlraume.

Ein sehr wichtiger Teil einer erfolgreichen Hopfendarre ist die Behandlung, welche das Material in dem Kühlraum oder Speicher erfährt. Das dazu dienende Gebäude wird heutzutage meist von der eigentlichen Darre getrennt errichtet und ist von 100 bis 200 Fuß entfernt, zum Schutze gegen Feuersgefahr. Die Abbildung bringt den Aufriß eines Kühlhauses mit den beiden Speicherstockwerken über dem Raume, wo der Hopfen in Ballen verpackt wird.

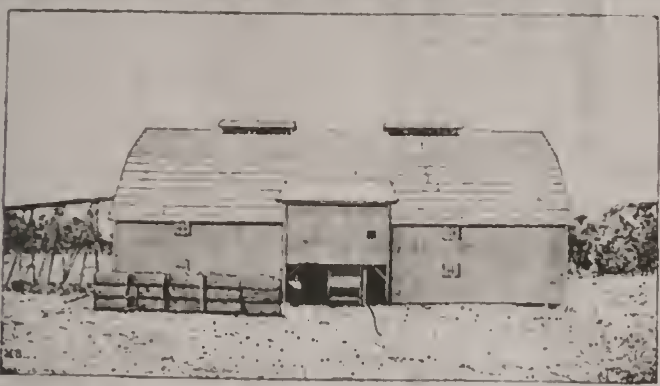


Fig. 15. Außenansicht des Kühlhauses mit Angabe der Packpresse.

In Notfällen kann man auch den untersten Raum für Speicherzwecke benützen, dann aber ist es nötig, den Hopfen zur Verpackung nach dem zweiten Stockwerke zu führen. Das Gebäude muß luftdicht gebaut sein, besonders in feuchten Gegenden, damit der lose liegende Hopfen nicht zuviel Feuchtigkeit aus der Luft aufsaugt. Die Verbindung zwischen Darre und Kühlraum wird durch eine Art Hochbahn hergestellt, auf der ein großer Karren läuft, der den frisch getrockneten Hopfen trägt. Die Seiten dieses Waggons sind so mit Scharnieren versehen, daß sie an dem schräg konstruierten Boden heruntergelassen werden können und der Hopfen leicht und mit geringer Handarbeit entladen werden kann.

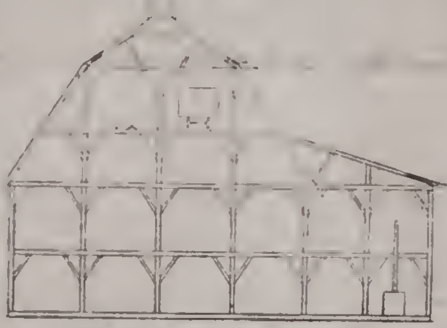


Fig. 16. Aufriß des Kühlhauses.

Der Hopfen wird dann auf dem Boden des Kühlraumes ausgebreitet, wo er die Wärme verliert und auch wieder einige Feuchtigkeit aus der Luft aufnimmt. Die Stengel sind gewöhnlich nicht so trocken wie die anderen Teile der Pflanze, und während des Schwitzprozesses wird die Feuchtigkeit gleichmäßig verteilt, und der Hopfen wird zähe und biegsam. Die am besten unterrichteten Hopfenzüchter wissen, daß während des Schwitzprozesses auch andere wichtige Veränderungen eintreten, welche auf die Güte des Produktes von wesentlichem Einflusse sind. Ein feineres und angenehmeres Aroma, wie auch ein besseres Aussehen stellt sich während des Schwitzprozesses ein, vorausgesetzt, daß man diesen Prozeß sorgfältig beobachtet und verhindert, daß der Hopfen zu feucht oder warm wird. Unter gewöhnlichen Verhältnissen umgeht man diese beiden Uebelstände dadurch, daß man den Hopfen aufstochert und ihn mit Gabeln wendet, oder daß man ihn nach einem anderen Teil des Kühlraumes schafft. Geschieht das zur rechten Zeit, so kann man sogar noch feucht gewordenen Hopfen auf diese Weise von seinem sauren, dumpfigen Geruche befreien. Wenn der Hopfen im Kühlraume zu feucht wird, dann kann man seine Güte dadurch verbessern, daß man über ihn eine Waggonladung heißen Hopfens, wie er gerade von der Darre kommt, schüttet. Andererseits kann man auch Hopfen, der im Kühlraume zu trocken geworden ist, dadurch verbessern, daß man ihn mit Hopfen vermischt, den man aus der Darre entfernt hat, ehe er vollständig getrocknet war. Zur richtigen Behandlung im Kühlraum ist die größte Sorgfalt und ein gesundes Urteil erforderlich, und je mehr Aufmerksamkeit man diesem Stadium der Hopfendarre schenkt, ein desto besseres Produkt wird man als Ergebnis derselben erhalten.

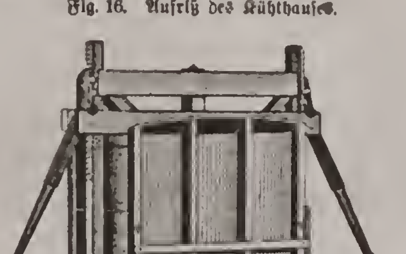


Fig. 17. Packpresse für Handbetrieb.

Fig. 18. Packpresse für Betrieb mit einem Pferde.

Die Verpackung.

Nachdem der Hopfen eine Woche oder zehn Tage lang im Kühlraume gelagert, hat er seinen Schwitzprozeß durchgemacht und befindet sich dann in gutem Zustande zum Verpacken. Man kann Hopfen viele Wochen lang im Haufen liegen lassen, ohne daß er wesentlich leidet, vorausgesetzt, daß der Speicher so dicht verschlossen ist, daß keine Feuchtigkeit aus der Luft eindringen kann. Wenn der Hopfen im richtigen Zustande für die Verpackung ist, dann enthält er gerade genug Feuchtigkeit, um biegsam zu sein und beim Zusammenpressen ein Brechen zu vermeiden. Wenn im Ballen zuviel Feuchtigkeit vorhanden ist, dann erhitzt sich der Hopfen bald und wird schwarz, wobei er an Farbe wie an Aroma leidet, wenn er nicht gänzlich ruiniert wird.

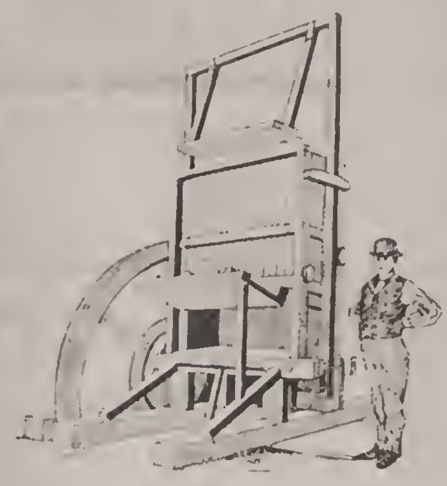


Fig. 19. Presse mit Antrieb durch zwei Pferde.

Zum Pressen des Hopfens in Ballen werden verschiedene Arten Hopfenpressen verwendet. In einigen Gegenden, wo man nur kleine Ernten erzielt, wird eine Handhebelpresse benützt. Der Typus dieser Sorte Presse, welchen Fig. 17 zeigt, bringt einen Ballen von 24 × 18 × 63 Zoll Umfang zustande. Zur Bewältigung großer Ernten wird aber immer eine Kraftpresse benützt. Eine moderne Presse, welche sich leicht mit einem Pferde betreiben läßt, ist in Fig. 18 zu sehen. Es ist dies eine aufrecht gebaute Maschine von 10 Fuß 4 Zoll Höhe und 30 Zoll Breite. Die Türen öffnen sich nach oben und werden durch einen Stabriegel geschlossen, der an jedem Ende der Presse in ein Lager greift. Die Endtore sind lose und können leicht entfernt werden, wenn die Türen offen sind. Die Preßplatte ist aus 4 × 4 zölligen Balken und 1 ¼ zölligen Brettern hergestellt, mit einem 16 zölligen Eisennab obenauf, an dessen Enden Doppelseile befestigt sind, mit deren Hilfe die Preßplatte heruntergezogen wird. Die Seile winden sich auf einer Rolle auf, die aus einer 26 zölligen Drehscheibe und einer 6 zölligen Trommel besteht, wozu eine 12 Fuß lange Deichsel benützt wird. Da das Seil sich zuerst auf der 26 zölligen Drehscheibe, dann aber auf der 6 zölligen Trommel aufwindet, so ist die Bewegung der Preßplatte nach unten anfangs rasch, wird aber sehr langsam, wenn die Hopfenmenge sich der richtigen Größe für den Ballen nähert. Bei dieser Presse wird für jeden Ballen der Behälter zweimal gefüllt und die Preßplatte zweimal heruntergedrückt. Der erzielte Ballen mißt gewöhnlich 19 × 26 × 53 Zoll.

Die sogenannte Sakramento oder „Bull Wheel" Presse erfordert für ihren Betrieb zwei Pferde. Der Behälter dieser Presse mißt 20 × 52 Zoll und ist 8 bis 10 Fuß hoch. Unter dem Behälter befindet sich ein 3 zölliger Stahlschaft, an dessen einem Ende ein Triebrad angebracht ist, welches 10 bis 12 Fuß im Durchmesser groß ist. An dem Schafte sind zwei 8 zöllige Zahnräder, welche in 4 Zoll breite Kammbahnen eingreifen, welche mit Bolzen an 4 × 4 Zoll × 16 Fuß lange Latten befestigt sind, die sich auf- und abbewegen. Diese Latten sind oben durch ein 4 × 12 zölliges Querholz von 7 Fuß Länge verbunden. Von diesem Querholze hängen zwei 4 × 4 zöllige, 8 bis 10 Fuß lange Stücke herab, an deren freien Enden die Preßplatte befestigt ist. Diese paßt genau in den Behälter, und sobald der Druck mittels der Zahnräder und der Reifenbahn in Betrieb tritt, preßt sie den Hopfen zusammen.

Der untere Teil des Behälters besteht an jeder Seite aus einer Tür, die so in den Angeln hängt, daß sie sich nach oben öffnet. Bei der Verpackung wird der Boden des Behälters mit einem Stücke Packleinwand von 2 Yards Länge und einer Breite von 42 bis 46 Zoll bedeckt, die Türen werden geschlossen, der Behälter wird mit Hopfen angefüllt, ein zweites, ähnliches Stück Zeug wird über den Hopfen gebreitet, und die Preßplatte wird heruntergelassen. Dann öffnet man wieder die Türen, die Enden des Zeuges werden mit Hanfpackzwirn zusammengenäht, und der Ballen wird aus der Presse entfernt. Der Durchschnittsballen aus dieser Presse mißt 20 × 24 × 52 Zoll und wiegt 180 bis 200 Pfund.

Der üble Gebrauch, daß man den Hopfen mit den Füßen zusammenstampft, um das Füllen des Behälters zu erleichtern, sollte gänzlich aufgegeben werden, da der dabei entstehende gebrochene Hopfen den Verkauf erschwert. Beim Füllen des Behälters können die Ecken des Ballens ein wenig fest gestampft werden, aber auch das sollte mit Sorgfalt geschehen, besonders wenn der Hopfen trocken ist. Ueberhaupt ist eine sorgfältigere Behandlung höchst empfehlenswert, da der Hopfen häufig auf dem Boden gebrochen und zerquetscht wird, ehe er in den Ballen kommt; dies aber gibt ihm ein schlechtes Aussehen.

Der Hopfen wird in Jute-Packleinwand von 16 oder weniger Fäden auf den Zoll verpackt. Ungefähr 5 Yards Packleinwand werden für jeden Ballen gebraucht. Diese wiegt ungefähr $7\frac{1}{2}$ bis 10 Pfund, und beim Verkaufe wird dafür 5 Pfund Tara in Anrechnung gebracht.

Kosten und Erträgnisse der Ernte.

Die Kosten der Hopfenkultur sind so verschieden wegen der Unterschiede in den Bodenwerten, den Arbeitslöhnen, dem Ertrage der Ernte und den Betriebsmethoden in den verschiedenen Gegenden der Vereinigten Staaten, daß es nicht möglich ist, einen Versuch zur Abschätzung der Gesamtausgaben für die Gewinnung einer Ernte anzustellen. Die Gefahr des Verlustes durch ungünstiges Wetter oder durch Insekten macht den Hopfenbau viel riskanter als den Anbau der üblichen Getreidearten. Die Schwierigkeit, in der Pflückezeit die nötigen Arbeitskräfte zu bekommen, hat dem Risiko der Kultur in den letzten Jahren noch vieles hinzugefügt. Einige Abschätzungen für die wichtigsten Ausgaben bei der Hopfenkultur sind nachstehend zu finden:

Wichtige Posten der Kosten der Hopfenkultur.

Setzlinge	2.—	bis	8.—	Dollar das Tausend
Spaliere	8.—	„	90.—	„ auf den Acker
Bindfaden	4.—	„	7.—	„ „ „ „
Bodenbearbeitung . . .	6.50	„	18.—	„ „ „ „
Ziehen der Ranken . .	11.—	„	22.—	„ „ „ „
Waschen	4.—	„	12.—	„ „ „ „

Pflücken	0.03	bis 0.05 Dollar das Pfund trocken	
Darren	0.01	„ 0.01½ „ „ „	
Verpackung:			
Packleinwand und Zwirn	0.60	„ 0.90	„ der Ballen
Arbeitslöhne	0.15	„ 0.25	„
Hopfenpreise	30.—	„ 40.—	„

Die Ergebnisse gehen je nach der Gegend weit auseinander, [illegible] in denselben Gegenden gibt es Unterschiede je nach der Bodenbeschaffenheit. In der nachstehenden Tabelle ist der Durchschnittsertrag an Hopfen vom Acker in den hauptsächlichen Hopfenstaaten nach dem Berichte des Vereinigten Staaten-Zensus für das Jahr 1900 angegeben:

Durchschnittsertrag an Hopfen auf den Acker in den Vereinigten Staaten für die Jahre 1879, 1889 und 1899.

Staaten	1879	1889	1899	Staaten	1879	1889	1899
	Pfund				Pfund		
New-York . .	554	547	630	Kalifornien . .	1022	1648	1469
Oregon . .	840	1155	954	Washington . .	1317	1626	1287

In guten Erntejahren wird auf besseren Böden der Ertrag gewöhnlich viel größer. In Kalifornien kann ein Acker 1800 bis 2400 Pfund hervorbringen, in Washington 1200 bis 2000 Pfund, in Oregon 1000 bis 1600 Pfund und in New York 800 bis 1500 Pfund. Die nachstehenden Zahlen aus der Veröffentlichung Nr. 50 des Statistischen Bureaus im Vereinigten-Staaten-Landwirtschaftsministerium geben die ungefähren jährlichen Erträge für die Vereinigten Staaten, wie sie nach unoffiziellen Abschätzungen für die Jahre 1901 bis 1906 zusammengestellt sind:

Jährlicher Ertrag der Hopfenernte in den Vereinigten Staaten von 1901 bis 1906 einschließlich.

Staat	1901	1902	1903	1904	1905	1906
	Tausend Pfund					
New York . . .	9000	5855	9000	11800	9360	12060
Kalifornien . . .	9360	10335	10920	12285	14235	20475
Oregon . . .	13485	16965	17550	17550	22191	23985
Washington . . .	6630	5850	5825	7410	9750	8775
Zusammen	38835	39000	44295	49125	55536	65295

Der Verkauf.

Das schwierigste Problem, dem sich der Hopfenbauer gegenübersieht, ist, wie er seine Ernte zu einem Preise verkaufen kann, der ihm einen anständigen Nutzen für sein Anlagekapital und seine Arbeit gewährt. Schon teilweise wegen der großen Preisschwankungen ist der Hopfenbau, vom geschäftlichen Standpunkt aus betrachtet, ungemein unsicher. Der Markt hängt stark von dem Vorrat an Hopfen ab, der noch von dem Vorjahre her auf den Speichern lagert, dann von den Ernteaussichten im In- und Auslande während des laufenden Jahres und von der mutmaßlichen Nachfrage, wie sie sich nach den beiden eben erwähnten Bedingungen abschätzen läßt. Während der Markt von diesen drei Faktoren abhängt, wird er auch stark von den Händlern, den Hopfenkäufern und den Mittelsmännern, welche zwischen dem Produzenten und dem Konsumenten stehen, beeinflußt.

Hopfen kann auf verschiedenen Wegen auf den Markt gebracht und den Kunden durch verschiedene Kanäle zugeführt werden. Die Beziehungen zwischen Produzent und Konsument bei einigen der Lieferungsformen sind in Fig. 20 veranschaulicht. Nur ein kleiner Prozentsatz der Hopfenbauer verkauft direkt an den Konsumenten, und sonst ist der Hauptteil des Gewächses durch die Hände von Mittelmännern. Verkäufe können an die Großhändler direkt durch ihre Einkäufer oder an die kleineren Händler in den einzelnen Ortschaften, die ihrerseits an die Großhändler verkaufen, gemacht werden; dann aber können die Hopfenbauer auch durch die Vermittlung eines Kommissionshändlers verkaufen, der als Agent für Produzent sowohl wie für Konsument auftreten kann. Der Makler

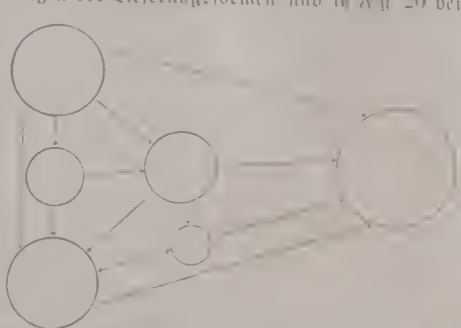


Fig. 20. Diagramm zur Veranschaulichung der Bewegung zum Markte (oben links Pflanzer; in der Mitte links Platzhändler; unten links Großhändler; in der Mitte oben Kommissionshändler; in der Mitte unten Makler; rechts Konsument).

oder Faktor dient als Mittelsmann zwischen den einzelnen Händlern oder zwischen Händler und Konsument. Alle diese Zwischenhändler haben eine anerkannte vollständig legitime Stellung im Hopfengeschäfte, solange sie ihre Tätigkeit darauf beschränken, zu den Marktpreisen, wie sie durch Angebot und Nachfrage normiert werden, zu kaufen und zu verkaufen, und mit ihrem Verdienste von den günstigen Bedingungen abhängen, welche sie im regelrechten Geschäftsgange herauszuschlagen vermögen. Unter den jetzt bestehenden Verhältnissen könnte die Hopfenernte ohne die Mittelsmänner gar nicht auf den Markt gebracht werden. Hopfenbauer mit nur kleinem Areal, die entfernt von den Konsumenten wohnen, könnten für ihre Ernte kaum einen Markt finden, selbst wenn sie die Schwierigkeiten, die mit dem Arrangement der Kreditverhältnisse verbunden sind, überwinden könnten. Der Produzent braucht gewöhnlich sein Geld sofort und verlangt deshalb Barzahlung; dagegen mag der Konsument nicht die nötigen Fonds an Hand haben, um bar für seinen Hopfen zu der Zeit zu zahlen, wo es für ihn notwendig ist, seine Einkäufe zu machen. Der Händler schafft diese Schwierigkeit aus dem Wege, indem er dem Produzenten seinen Vorrat gegen Barzahlung abnimmt oder kurze Fristen arrangiert und dem Konsumenten unter Bedingungen, die diesem passen, verkauft. Obwohl man gemeinhin auf die Gegend, in der der Hopfen gezogen worden ist, viel Wert legt, so ist es doch offenbar, daß dem geographischen Ursprung als Wertmesser für die Qualität zu viel Bedeutung beigemessen wird. Es ist schon wiederholt bewiesen worden, daß Händler und Konsumenten nicht mit Bestimmtheit unterscheiden können, aus welcher Landesgegend eine Probe kommt, wenn sie sich nur auf eine einfache Prüfung beschränken. Es ist sogar vorgekommen, daß Proben aus demselben Hopfengarten, die nur unter etwas verschiedenen Bedingungen dem Darrprozesse unterworfen worden waren, von erfahrenen Hopfenkennern ganz getrenntliegenden Landstrichen zugeschrieben wurden.

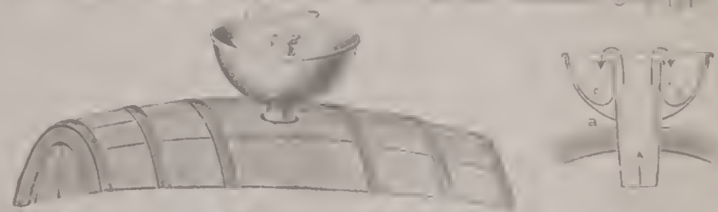
Der Preis, den der Konsument für Hopfen zu bezahlen gewillt ist, hängt großenteils von der Provenienz ab, wodurch es häufig möglich gemacht wird, daß Hopfen, der in dem einen Landesteile gezogen worden war, geliefert wurde, obwohl der Kauf doch für Hopfen abgeschlossen war, der aus einer anderen Gegend stammte und deshalb einen anderen Preis hatte. Leider gibt es bei der Bewertung von Hopfen keine feststehenden Normen für die Qualität, und außerdem legt man unbedingt viel zu viel Wert allein auf die Provenienz des Produktes. Wenn auch die Provenienz einige Bedeutung haben mag, so ist doch ihr Wert als Grundlage für die Qualitätsbeurteilung [illegible] gleich mit den [illegible] Proben, wie sie gewöhnlich angewendet werden, wenn man den Wert des Hopfens feststellen will. Bei der Feststellung des relativen Wertes von verschiedenen Sorten Hopfen würde eine bestimmte Schätzungsgrundlage, welche sich auf den wirklichen Eigenschaften aufbaut, nur auf einer [illegible] von [illegible] te, von dem größten Werte für Produzent wie Konsument sein.

Die gegenwärtig herrschenden unbefriedigenden Zustände auf dem Hopfenmarkte zeitigten Verbesserungen nach verschiedenen Seiten hin. Eines der größten Bedürfnisse der Hopfenindustrie ist ein vollständiger und leichter zugänglichen statistischen Aufschluß über Produktion und Verbrauch zu finden, nicht nur, damit die Hopfenzüchter ihre Anbaufläche nach der mutmaßlichen Nachfrage bemessen können, sondern damit man auch durch Kenntnis des Verbrauches während des laufenden Jahres, des noch in Händen der Konsumenten verbleibenden Vorrates und der Ernteaussichten im In- und Auslande sich eine intelligente Ansicht über mutmaßliches Angebot und Nachfrage, sowie über die Preise, die man demgemäß billigerweise erwarten kann, zu bilden vermag. Aus den vierteljährlich von den Beamten des Binnensteueramtes gemachten Berichten [illegible] man erkennen kann, welche Menge Hopfen im ganzen verbraucht worden ist, und aus diesem Verbrauche — je nachdem er gestiegen oder gefallen ist — konnte man auf die Gesamtqualitäten des Marktes schließen. Auch für häufige verläßliche statistische Angaben über die Ernteaussichten in Europa ist das größte Bedürfnis vorhanden. Der Hopfenmarkt wird von den Preisen in den Vereinigten Staaten, England, Deutschland und Oesterreich [illegible], und da der Ueberschuß in den Vereinigten Staaten fast ausschließlich nach England exportiert wird, so beeinflußen die Ernteaussichten im Auslande so gut wie gänzlich die amerikanischen Preise. Es sind auch verläßlichere und eingehendere statistische Aufschlüsse über die Produktion im Inlande vonnöten. Es werden so viele übertriebene Berichte nur zu dem Zwecke in Umlauf gebracht, um den Markt zu beeinflussen, daß ein genauer Zensus über das angepflanzte Areal, über das abgeerntete Areal und die Anzahl der gewonnenen Ballen von unschätzbarem Werte für den Produzenten sein würde, und dieses Ziel würde viel leichter zu erreichen sein, wenn die Hopfenbauer selbst eifrig mitwirkten.

An der Küste des Stillen Ozeans sind verschiedene Verbände von Hopfenproduzenten auf ähnlichen Grundlagen und mit denselben allgemeinen Zielen und Zwecken wie die Vereinigungen von Zitronen- und Apfelsinenzüchtern und anderen im südlichen Kalifornien gegründet worden. Andere Verbände, nach dem Vorbilde der Hopfenbauvereine und Verbände in Europa, setzen die Hopfenbauer instand [illegible], [illegible] Waren und sich eher Berücksichtigung zu verschaffen, [illegible] Individuen können. Die Industrie ist in den [illegible] Staaten [illegible], daß eine kleine Anzahl solcher Verbände [illegible] ihre Mitgliedschaft einschließen könnte. Bei [illegible] der Mitglieder dieser Verbände, und [illegible] wenn [illegible] und mißt [illegible] den Hopfen- [illegible] entsprechende Aufstellung und Verteilung [illegible] Aufschlüsse über Produktion und Verbrauch [illegible] Maße mit dem [illegible] aus edleren Erleichterungen [illegible] des Verkaufs [illegible] Geschäftes [illegible].

Kleine Mitteilungen.

Stoß-(Gär-)Trichter in der Brauerei. [illegible] die Lage [illegible] und [illegible] Ueberall [illegible] wie [illegible] in



verschiedenen Formen verwendet, die das an [illegible] sodaß es nicht wieder ins Faß zurückläuft, aber auch nicht der Küfer [illegible] in den Trichtern gesammelt. Wer kann zu irgend [illegible] verwendet werden. Die Stoßtrichter haben jedoch vielfach den [illegible] auch angeführt sind, hauptsächlich [illegible] anweisen, die [illegible] schwer zu [illegible] Verbindung sind [illegible] im Wege stehen. Die Firma Maaus & T[illegible] konstruiert der diese Fehler nicht haben soll, [illegible] sowohl im Bezug auf praktische Form [illegible] und gründliche Reinigung. Der [illegible] „Rein" D. R. G. M. Nr. 337926 besteht aus einer [illegible] aus einem gleich starken Steigrohr [illegible] Schale a. Einsatz [illegible]. Durch letzteren erhält der [illegible] Stabilität und der Trichter [illegible] zu reinigen sind. Der ganze Stoßtrichter ist im [illegible] und [illegible] haltbarkeit. Eventuell kann der [illegible] verzinnt [illegible].

Genossenschafts-Aktienbrauerei Union A.-G. in Saarbrücken. [illegible] dieses Unternehmens [illegible] das am 30. September [illegible] schließt mit einem Fehlbetrag von 29591 M. ab. [illegible] 18000 hl Bier. [illegible] zusammen [illegible]: 861373 M. [illegible] und Einrichtungskonten, ferner 84532 M. Vorräten, 882 M. Kasse und 112047 M. Außenstände. Die Passiven bestehen aus 500000 M. Aktienkapital, 416000 M. Hypotheken und [illegible] M. Verbindlichkeiten. Der Geschäftsbericht [illegible] Bierabsatz, sowie die [illegible] Brauindustrie [illegible] Deckung finden konnte, und [illegible] Rabatt von 80 Pf. vom Hektoliter einen wesentlichen Ausfall darzeitigt [illegible] für das neue Betriebsjahr und nach dem [illegible] Bierpreise ebenfalls keine erfreulichen. Wenn [illegible] Absatz tatkräftig eintreten, wird für das laufende Jahr ein besseres Resultat erhofft.

Patent-Liste für Oesterreich.

Patent-Uebertragung:

Von Hermann Adolf [illegible] an die Firma International [illegible] Limited in London. Verfahren und Vorrichtung zur Vergärung [illegible].

Patent-Erlöschungen durch Zeitablauf:

Ba[illegible] Lapp, Leipzig-Lindenau: Verfahren zum Trocknen, Darren [illegible] von gekeimtem und ungekeimtem Getreide unter Benutzung von [illegible].

David [illegible] und Jean François Berzo, beide in [illegible] Vorrichtung zum Füllen und Verschließen von Flaschen.

Tages-Nachrichten.

Alzey. Die Brauer der Genossenschaftsbrauerei vormals Th. Kleinknecht sind wegen Lohndifferenzen in den Streik eingetreten. Da die Brauereileitung den eingereichten Tarif nicht anerkennen will, sind einige kleine Wirte und Küfer die einzigen, welche durch den Streik in Mitleidenschaft gezogen werden.

Basel. Der Basler Wirteverein hielt dieser Tage im Warteck eine Vereinssitzung ab, um den Entwurf zu einem neuen Wirtschaftsgesetze zu besprechen, und um im besonderen die Stellung der Wirte zum Artikel 30 dieses Entwurfes festzustellen. Dieser Artikel regelt die Dienstverhältnisse und bestimmt, daß auch die Familienangehörigen des Wirtes beinahe in gleicher Weise wie die Dienstboten den dort gegebenen Anordnungen unterstellt sind. Wenn auch im allgemeinen die Wirte nicht viel gegen das neue Gesetz einzuwenden haben, so sind sie doch damit nicht einverstanden. Es soll auch an das Departement des Innern in diesem Sinn eine Eingabe gerichtet werden. Auf die Beschwerden über Verletzung des Flaschenbiervertrages konnte nicht eingegangen werden, da solche Beschwerden schriftlich dem Vorstand eingereicht werden müssen.

Bamberg. Während der Landwirtschaftlichen Ausstellung sind in fünf Bierbuden vom 31. Mai bis einschließlich 3. Juni 600 Hl. Bier verzapft worden.

Berlin. Am Donnerstag abend sank in der Nähe der Inselbrücke auf der Spree ein Frachtdampfer, der gerade mit einer beträchtlichen Bierladung nach Rüdersdorf abfahren wollte. Die schwere Ladung war auf Deck untergebracht, während die leichten Frachtgüter unten im Schiffsraum lagerten. Als sich der Dampfer nun in Bewegung setzte, kamen zahlreiche Fässer ins Rollen, das Fahrzeug neigte sich stark seitwärts, ein gut Teil der kostbaren Ladung ging über Bord, und man befürchtete eine Kesselexplosion. Doch trat das Schlimmste nicht ein: ein Mann der Besatzung sprang jedoch über Bord und mußte durch Schiffer aus dem Wasser gezogen werden. Inzwischen war die Feuerwehr eingetroffen und versuchte sofort mit einer Dampfpumpe, das Schiff flottzumachen. Außer dem Schiffseigner ist niemand zu Schaden gekommen.

Berlin. Noch vor Beginn der Sommerpause des Bundesrates, also etwa Ende Juni bis Anfang Juli, soll eine Besprechung der Finanzminister der Einzelstaaten über die im Reichsschatzamt ausgearbeiteten Pläne für die Reichsfinanzreform hier stattfinden.

Corbach (Waldeck). Das Gasthaus zum Fürsten von Waldeck ist für den Preis von 75000 M. von Herrn Brauereibesitzer Köhte in Sachsenberg erworben worden und wird gegenwärtig durch ein drittes Stockwerk vergrößert.

Dortmund. Der in der Brauerei Thier & Ko. beschäftigte Brauer Jean Keitel wurde bei der Arbeit von einem Hitzschlag betroffen. Der Kranke mußte ins Luisenhospital geschafft werden.

Erlangen. Bei der Zwangsversteigerung ist das Weitendörfersche Anwesen, Essenbacher Straße 2, von Herrn Brauereidirektor Kastner aus Burgfarrnbach als Vertreter des Kaiserhofenvereins Wilhermsdorf um 54000 M. ersteigert worden.

Geltung (Oberbayern). Die Gastwirtswitwe Anna Wagner ließ Neigbier und von den Gästen stehengelassene Bierreste in Flaschen sammeln und stellte dann diese Gemisch den Knechten und auch oftmals den Gästen vor. Nach einer Festlichkeit wurden Hunderte von Bierresten gesammelt, auf Eis gestellt und in Flaschen abgezogen, um dann wieder verkauft zu werden. Einem Knecht wurde nach dem Genuß dieses Getränkes ganz übel, worauf er den Dienst ohne Kündigung verließ. Die Wirtin erstattete Anzeige und beschwor in der Verhandlung, nie solche Pantschereien getrieben zu haben, worauf der Knecht zu acht Tagen Gefängnis wegen Dienstentlaufens verurteilt wurde. Durch Aussagen mehrerer Zeugen wurde die Wirtin überführt, den Gästen und Dienstboten geradezu gesundheitsschädliche Getränke zusammengepantscht zu haben. Sie wurde nun zu 120 M. Geldstrafe oder 20 Tagen Haft verurteilt. Außerdem wurde gegen die 70jährige Frau das Verfahren wegen Meineids eingeleitet.

Groß-Lichterfelde. Der Ratskeller wurde auf fünf weitere Jahre an die Feldschloßbrauerei verpachtet.

Haselmühle (Oberpfalz). Das Anwesen des Oekonomen Paul Brener wurde von Herrn Metzgermeister und Bierbrauereibesitzer Johann Schmidt in Amberg um 6000 M. käuflich erworben.

Koblenz. Vor einiger Zeit hatten sich 34 Wirte vor dem hiesigen Schöffengericht wegen Duldung von gewerbsmäßigem Glücksspiel zu verantworten. Sie hatten in ihren Räumen die sogenannten Kleeblattautomaten aufgestellt, an denen mit Geld nach einem Ziel geschossen wird. Sie wurden damals freigesprochen. Die Staatsanwaltschaft legte jedoch Berufung ein, und so gelangte die Sache vor die Strafkammer. Bei der Verhandlung war ein Automat aufgestellt, an dem einige besonders geübte „Schützen" ihre Kunst vor Gericht zeigten. Es ergab sich, daß diejenigen, die sich bei dem Automat eingeschossen hatten, bei zwölf Schüssen achtmal vorbeischossen. In einer Wirtschaft hatten dieselben Zeugen den ganzen Automat geleert. Ein Zeuge aus Moselweiß hatte an einem solchen Automat seinen ganzen Wochenlohn von 17 M. verspielt. Das Gericht gelangte zu der Entscheidung, daß hier ein Glücksspiel vorliege, daß jedoch die Wirte, die das Spiel geduldet hatten, in gutem Glauben gewesen wären, auf eine Bestrafung demnach nicht erkannt werden solle. Auch habe die Polizei selbst eine Zeitlang die Automaten geduldet, und verschiedene Schutzleute hätten viel damit gespielt. Ausdrücklich aber wurde betont, daß es sich um ein gesetzlich verbotenes Glücksspiel handle, und daß von jetzt an jeder Wirt, der das Spielen an dem Automaten dulde, bestraft werde.

Lehen (Salzburg). Der Gasthof Lehener Hof wurde im Wege der Zwangsversteigerung an die Stieglbrauerei in Salzburg um 70000 Kr. verkauft.

Leipzig. In einer Versammlung der Brauereiarbeiter Leipzigs und der Umgegend wurde berichtet, daß nunmehr auch die Tarifverhandlungen mit den nicht zum Brauereiverein gehörenden Brauereibesitzern beendet seien und zu einem befriedigenden Abschluß geführt hätten. Zum Teil seien die Bedingungen für die Arbeiter noch günstiger als in dem mit dem Brauereiverein abgeschlossenen Vertrag.

London. Vom 17. bis 23. Oktober 1908 wird hier die 30. Internationale Jahresausstellung für Brauerei, Malzfabrikation, Brennerei, Mineralwassererzeugung und Lebensmittelgeschäfte abgehalten werden.

Solothurn. In Ergänzung unserer gestrigen Mitteilung über die Delegiertenversammlung des Schweizerischen Wirtevereins ist noch folgendes zu berichten: In der Frage des Flaschenbierkampfes wurde zur Tagesordnung geschritten, immerhin in der Meinung, daß Direktion und Wirtesekretär die Sache auch fernerhin im Auge behalten und mit aller Energie den Genossenschaftsgedanken zu heben und zu kräftigen suchen sollen. Zentralpräsident Merz in Bern referierte sodann über die Absinthinitiative. Er beantragte Ablehnung derselben und Annahme einer dahinzielenden Resolution. Diese Resolution wurde einstimmig angenommen und im weiteren beschlossen, dem Komitee gegen die Absinthinitiative zu den Agitationskosten 2000 Fr. beizusteuern, ein Plakat zu veröffentlichen und das Vereinsorgan der Agitation gegen die Absinthinitiative zur Verfügung zu stellen.

Stuttgart. In der Aktienbrauerei Wulle verunglückte ein 21 Jahre alter, in Gablenberg wohnhafter Taglöhner dadurch, daß ihm der linke Unterschenkel zwischen die beiden Exzenter des Pumpwerkes, an welchem er mit Oelen beschäftigt war, eingeklemmt wurde. Er trug eine bedeutende Quetschung davon und mußte ins Krankenhaus gebracht werden. Das Pumpwerk, welches zum Oelen abgestellt war, wurde vom Maschinisten, ohne daß dieser vom Vorhaben des Verunglückten in Kenntnis gesetzt worden war, in Bewegung gesetzt. Wen das Verschulden trifft, ist noch nicht aufgeklärt.

Ulm. Die Münchener Pschorrbrauerei hat gegen eine hiesige Brauerei einen Prozeß angestrengt, weil diese bei der Ankündigung eines von ihr gebrauten Doppelbieres den Ausdruck „Ersatz für Salvator" gebraucht hat.

Würzburg. Die Arbeiter des Brauhauses Würzburg sind am Freitag früh wegen Lohnstreitigkeiten in den Ausstand getreten.

Außerordentliche Generalversammlung:
Am 30. Juni Aktienbrauerei Bernburg (Herabsetzung des Aktienkapitals auf 100 000 M.).

Hopfenmarkt.

(Nachdruck verboten.)

Nürnberg, 6. Juni. Ein gestern nachmittag aufgetretenes Gewitter hatte eine Reihe von Niederschlägen zur Folge, die auch heute noch andauern. Nach der starken Hitze der letzten Tage bilden diese Regen eine wohltuende Erfrischung für alle Lebewesen und nicht zum wenigsten für das gesamte Pflanzenreich. Mit dem Gewitter war zwar auch Hagel verbunden, der strichweise Schaden angerichtet haben mag, aber der größere Gewinn des Witterungsumschlages liegt doch in der erfrischenden Wirkung auf alle Feldfrüchte. Freilich wird jetzt für die bevorstehenden Pfingstfeiertage, das holde Fest der Maien, wieder die Rückkehr sonnigen, warmen Wetters gewünscht, und hoffentlich verdirbt der Wettergott den vielen Erholungsuchenden nicht das heiß ersehnte Vergnügen, die beiden Tage zu näheren oder weiteren Ausflügen in die schöne Natur zu benützen. Gegen gestern ist die Abkühlung eine recht fühlbare, denn das Thermometer meldet zur Stunde nur 14 Grad C. Auf dem Hopfenmarkte ist in der zweiten Wochenhälfte fast völlige Geschäftsstille eingekehrt, die auch durch die gegenwärtigen jüdischen Feiertage mit veranlaßt sein mag. Die Umsätze sind auf ein Minimum gesunken und erstrecken sich auf wenige Ballen täglich, die meist aus grünfarbigen Mittelsorten zu 32, 35, 38 M. genommen werden. Da die Berichte über das Gedeihen der jungen Hopfenpflanze von überallher recht günstig lauten, besteht weder für den Konsum noch für den Handel Veranlassung, sich noch mehr [illegible] Bedarf zu decken, als es bereits geschehen ist. Der Ausfuhrhandel ist [illegible] ganz untätig. Umgesetzt wurden in dieser ganzen Woche 290 Ballen, gegen 270 Ballen in der vorangegangenen; weit geringer waren die Zufuhren, welche auf 70 Ballen beschränkt blieben und ausschließlich von der Bahn bestritten wurden. Das Land hat überhaupt nichts geliefert. Die Stimmung und Haltung des Marktes ist am Wochenschluß gedrückt mit Neigung [illegible] Preisstandes zugunsten der Käufer.

		Landzufuhren	Bahnabladungen	Tagesumsätze
Montag,	1. Juni	—	20	100 Ballen
Dienstag,	2. „	—	—	80 „
Mittwoch,	3. „	—	20	40 „
Donnerstag,	4. „	—	10	20 „
Freitag,	5. „	—	—	20 „
Samstag,	6. „	—	20	30 „

Heutige Notierungen des Nürnberger Marktes (Preise für 50 Kilo):	Gute Mark	Mittlere Mark	Geringe Mark
Markthopfen	45–52	35–40	20–28
Gebirgshopfen	55–60	—	
Spalter Landsiegelgut leichter Lage	60–70	45–52	30–35
Hallertauer	62–68	42–50	28–32
Hallertauer Siegelgut	65–72	45–52	
Württemberger	62–70	42–50	28–32
Badische	62–70	42–50	28–32
Elsässer	52–60	38–45	—
Posener	62–70	38–45	—

Auswahl erzielt bis 5 M. über den Notierungen der guten Ware stehende Preise.

Umsatz und Durchschnittspreise des Nürnberger Marktes in dieser Woche und seit Beginn der Saison, sowie in gleicher Zeit der beiden Vorjahre	Umsatz Ballen	Durchschnittspreise der Woche Mark
Umsatz in der Zeit vom 1. September 1907 bis 30. Mai 1908	82710	
Hierzu Umsatz dieser Woche vom 31. Mai bis 6. Juni 1908	290	35–40
Ergibt Gesamtumsatz vom 1. Septbr. 1907 bis 6. Juni 1908	83000	
Umsatz in der Zeit vom 1. September 1906 bis 25. Mai 1907	77 5[illegible]	
Hierzu Umsatz der Woche vom 2. bis 8. Juni 1907	[illegible]	70–80
Ergibt Gesamtumsatz vom 1. Septbr. 1906 bis 8. Juni 1907	77 [illegible]	
Umsatz in der Zeit vom 1. September 1905 bis 2. Juni 1906	101 [illegible]	
Hierzu Umsatz der Woche vom 3. bis 9. Juni 1906	700	40–50
Ergibt Gesamtumsatz vom 1. Septbr. 1905 bis 9. Juni 1906	102[illegible]	

Saaz, 5. Juni. Die warme, äußerst günstige Witterung hielt bisher an, und die Entwicklung der Hopfenpflanze schreitet daher rasch fort. Dieselbe hat sich kräftig entwickelt und steht zumeist in halber Stangen- oder Drahthöhe, ist gesund und von Ungeziefer frei. Ueber das hiesige Platzgeschäft läßt sich nichts Neues berichten. Gekauft wird nur sehr wenig, und haben die Preise keine Veränderung aufzuweisen. Dieselben bewegen sich für Saazer Hopfen zwischen 140 und 170 Kr. für 50 Kilo. Die Vorräte in diesen Hopfen dürften höchstens 250 bis 300 Ballen betragen. Pfister & Würfl.

Dauba (Böhmen), 5. Juni. Die Hopfenpflanze steht im allgemeinen sehr gut; nur ein kleiner Teil ist noch im Wachstum zurück. Es zeigten sich auch etwas Fliegen, die sich aber zumeist wieder verloren haben. A. Hahn.

W **New-York,** 3. Juni. Der Verkehr auf dem hiesigen Hopfenmarkt ist, wie gewöhnlich um diese Zeit des Jahres, ein sehr lustloser. Die Aufmerksamkeit der Marktinteressenten ist auf die Aussichten für die diesmalige Hopfenernte gerichtet, denn es wurden in neuerer Zeit zahlreiche Gerüchte laut, denen gemäß der Anbau eine so gewaltige Einschränkung erfahren hab[e], daß nur unter den günstigsten Witterungsverhältnissen ein Durchschnittsertrag zu erwarten sei. Es ist natürlich noch viel zu früh, den Umfang desselben jetzt bereits zu veranschlagen, doch von zuverlässiger Seite glaubt man auf etwa 230000 bis 250000 Ballen rechnen zu dürfen. Auf den Märkten der pazifischen Küste herrschte zeitweilig ein leidlich angeregter Ton, doch vermochten sich die Preise nicht in nennenswertem Maße zu befestigen, vermutlich weil noch immer etwa 35000 Ballen aus letzter Ernte und 20000 Ballen aus vorletzter in erster Hand vorhanden sind.

W **Waterville** (Staat New-York), 27. Mai. In der vergangenen Woche herrschte ein vorzügliches Wachswetter, sodaß die jungen Hopfenpflanzen im Wachstum große Fortschritte machten. Das erste Anleiten der Hopfenreben ist nunmehr überall teilweise im Gange, teilweise bereits erledigt. Das Wachstum verspricht auch weiterhin kräftig fortzufahren und mangels unerwarteter Zwischenfälle einer Ernte entgegenzugehen, die sich früheren guten Jahrgängen trotz der fortwährenden jetzigen Voraussagungen einer heurigen schlechten Ernte und niedriger Preise wird an die Seite stellen können. Aus Cooperstown wird berichtet, daß der Platzmarkt andauernd in Untätigkeit verharrt. Die Nachfrage nach noch vorrätigem Hopfen hat zurzeit so gut wie völlig ausgesetzt, sodaß die Pflanzer ihre Ware schon gar nicht zum Markt bringen. Nach Mitteilungen aus Deansboro schreiten auch im dortigen Bezirke die jungen Hopfen im Wachstum kräftig vorwärts und sind so weit, um angeleitet zu werden.

S **Schoharie** (Staat New-York), 27. Mai. Das prächtige Wetter der letzten paar Tage hatte ein außerordentlich rasches Wachstum der jungen Hopfenpflanzen zur Folge. Das erste Anleiten derselben ist im Gange; die Gärten sind heuer jedoch ungleichmäßig bewachsen, da viele Stöcke, namentlich in den älteren Pflanzungen, schlecht überwintert haben und abgestorben sind. Im Staate New-York sind 10 % der Anbaufläche von Hopfen in diesem Jahre umgepflügt worden. In einer Mitteilung aus Cherry Valley wird die Ansicht vertreten, daß die Pflanzer im dortigen Bezirke, die in diesem Frühjahr ihre Hopfengärten umackern, einen großen Mißgriff machen, da die große Verminderung der Anbaufläche in England sicherem Erwarten nach im nächsten Jahre eine bemerkenswerte Steigerung der Hopfenpreise zur Folge haben werde.

L **Portland** (Oregon, Vereinigte Staaten), 23. Mai. Am Platzmarkte vollziehen sich nur geringe Umsätze. Die Käufer und Verkäufer stimmen in ihren Ansichten nicht überein und zeigen vorerst keine Neigung, einander

näherzukommen. Meldungen aus Kalifornien zufolge hat sich dort im Anschluß an gesteigerte Nachfrage für Ausfuhrzwecke der Markt belebt. Der Vertreter einer New-Yorker Firma kaufte etwa 1500 Ballen Sakramento-Hopfen zu 4¼ und 4½ Cent, ferner wurde, einer allerdings unverbürgten Mitteilung zufolge, für einen kleinen Posten Sonoma-Hopfen der Preis von 8 Cent bezahlt.

Anderweit vorliegende Hopfenberichte:

Spalter Land. Windsbach. Der Hopfen ist im besten Wachstum, hat schon eine ansehnliche Höhe erreicht und muß angebunden werden.

Baden. Mannheim. Die häufigen Niederschläge in Verbindung mit sehr warmer Witterung förderten das Wachstum der Hopfenpflanzen ungemein. Aus allen süddeutschen hopfenbautreibenden Bezirken kamen neuerdings günstige Berichte über den Stand der Pflanzen, deren Ranken bereits halbe Stangenhöhe erreicht haben. Beschädigungen durch Ungeziefer wurden bisher noch von keiner Seite gemeldet.

Böhmen. Saaz. Wir haben jetzt hochsommerliche Temperatur, die bis 28 Grad R. im Schatten stieg, mit Rücksicht auf die vielen vorausgegangenen Niederschläge eine wahre Treibhaustemperatur. Trotz der verspäteten Vegetation sieht man heute schon Hopfen bis zu drei Meter Höhe. Im Hopfengeschäfte ist noch immer viel Ruhe bis auf einzelne geringe Umsätze. Die Preise haben keinerlei Neigung zum Zurückgehen. Unter 140 Kr. ist Saazer Hopfen nicht zu haben, prima Ware noch bedeutend höher.

Gerstenmarkt.

Bingen. Am Getreidemarkt vom 3. Juni notierten: Pfälzer Gerste 21 M. nominell, Mais 16.50 M.

Bukarest. Die in der Vorwoche einsetzenden Regen haben sich im Berichtsabschnitt fast über das ganze Land ausgebreitet mit Ausnahme der Dobrudscha und einigen Teilen der Distrikte Dorohoi, Botoschau, Galatz, Calarasch, Bukarest und Giurgewo. Ziemlich ausgiebig regnete es im Innern der Maldau in den Bergregionen und im Gebirg. Sollte der Regen bis heute andauern, so ist die Weizenernte gerettet, und es sind auch für die Maisernte gute Aussichten vorhanden. Auf festeres Amerika hin hat sich unser Markt auch für Gerste wieder befestigt, obwohl die Verbrauchsmärkte einstweilen noch nicht folgen wollten. Für 58.59 Kilo-Ware prompt fordert man 123 bis 124 M. für Hamburg. Das Hafergeschäft bewegt sich in engen Grenzen. 43 44 Kilo-Ware prompt notiert 13.50 bis 13.75 Fr. fur Marseille. Mais ist sehr gesucht, und zwar ist Antwerpen der beste Markt. Die Preise, die man in den letzten Tagen im Lokohandel bezahlte, übersteigen die Auslandsparität. Galfoz-Mais ladend wurde zur Parität von 119 bis 119.50 M. nach England verkauft. Grober Donau wurde zur Parität von 119.50 bis 120 M. nach Schottland und echter Cinquantino zur Parität von 119 bis 119.25 M. nach Rotterdam gehandelt.

Essen. Am Fruchtmarkt vom 1. Juni notierten: fremder Hafer 17 bis 20 M., Futtergerste 14.80 bis 15.50 M., Mais 15.80 bis 16.50 M. die 100 Kilo, Frachtparität Essen, ohne Sack, bei Abnahme von Doppelladungen.

Mannheim. Auch in der abgelaufenen Woche blieb der Verkehr im Getreidehandel in den Grenzen der Bedarfsversorgung für die nächste Zeit zu ungefähr vorwöchentlichen Preisen. Pfälzer Braugerste (nominell) 21 bis 22 M., inländischer Hafer 18 M., russischer 18.25 bis 18.75 M., Laplata-Hafer 17 bis 17.50 M., Laplata-Mais 16.75 M., Donaumais 16.75 M., brutto mit Sack die 100 Kilo.

Mainz. Am Fruchtmarkt vom 5. ds. Mts. wurden gegen Barzahlung, bahnfrei hier, notiert: Futtergerste 14.50 bis 16.50 M., inländischer Hafer 18 M., ausländischer 18.50 M., Mais 16.75 M., getrocknete Biertreber 13 bis 13.50 M., Malzkeime 12 bis 12.50 M., Maisschrot 17.50 M. für 100 Kilo.

Nikolajeff. Für Gerste von 58 bis 59 Kilo wurden von Hamburg 120 M. auf Juni geboten, ein Preis, der aber keine Berücksichtigung finden konnte, da hier bereits die Parität von 122 M. bezahlt worden ist. Nachfrage besteht nur von Norddeutschland her.

Odessa. Gerste lag von 59 bis 60 Kilo schwimmend bedang in Hamburg 121.50 M. cif; am Rhein erzielte solche Gerste schwimmend auf Rotterdam 122.50 M. cif. Holland bezahlte dafür 143 fl. cif.

Pest. Wie die beim Kgl. Ungarischen Ackerbauministerium bis 1. Juni eingelaufenen Berichte besagen, hat in der zweiten Hälfte des Monats Mai ein nach langer Trockenheit und windigem Wetter, sowie großer Hitze eingetretener, einen beträchtlichen Teil des Landes umfassender gewitterartiger Regen günstig auf die Landwirtschaft eingewirkt. Wo der Regen genügend ausgiebig war, hat sich die Lage gebessert, trotzdem zeigen die Pflanzen beinahe im ganzen Lande den großen Mangel an Regen, was noch durch die plötzlich eingetretene große Wärme gesteigert wird, und zeigen sich die schädlichen Folgen sowohl an den Winter- als auch an den Sommersaaten. Demnach ist der landwirtschaftliche Stand auch heute nicht günstig, und mit voller Bestimmtheit kann behauptet werden, daß in Ermanglung eines Landregens in sehr vielen Gegenden, insbesondere im großen Teile des Alföld, die Ernteaussichten einen kritischen Charakter annehmen können. Was besonders die Gerste betrifft, so dürfte das Areal der Wintersaat auf 1080000 Katastraljoch zu schätzen sein, jenes der Sommersaat wird auf 1790865 Katastraljoch geschätzt. Die zufriedenstellende Entwicklung der Wintersaat könnte nur die große Hitze beeinträchtigen; die Saat schießt schon in Aehren, und würde ihr nur Regen nottun. Auch die Ernteaussichten der Sommergerste könnten nur durch die große Hitze und Dürre beeinträchtigt werden, verlangt jedoch auch nach Regen, insbesondere wo bisher nur geringe oder überhaupt keine Niederschläge waren. Die Ernteaussichten stellen sich übrigens wie folgt: Am linken Donauufer ist die Saat stellenweise schütter und niedrig, beginnt Aehren zu werfen. Stellenweise, wo reichhaltige Niederschläge waren, ist die Saat gut entwickelt, nur ist sie vielfach vom Unkraut überwuchert und stellenweise auch von Rost befallen. Am rechten Donauufer ist die Saat der Dürre und Hitze wegen niedrig und stellenweise gebleicht. Regen würde dringend nottun. Die Saat wirft Aehren, ist vielfach von Unkraut durchzogen; im Komitat Komarom zeigt sich stellenweise Rost. Zwischen Donau und Theiß sind die Saaten noch gesund, benötigen jedoch sehr des Regens. Schüttere und niederstehende Saaten sind häufig. Stellenweise schoß ist die Saat schon entwickelt und wirft Aehren. Am rechten Theißufer ist wegen Regenmangels die Saat niedrig und schütter, ist auch nicht entsprechend bebuscht. Unkraut wuchert ziemlich überall, stellenweise schädigen auch Insekten die Saat, die Regen braucht. Am linken Theißufer leidet die Winter-, besonders aber die Sommersaat viel unter Hitze und Dürre. Die niedrige Saat schießt schon in Aehren. Im Komitat Szatmar ist stellenweise Rost aufgetreten, im Komitat Szilagy der Brand. Insektenschäden meldet das Komitat Szilagy. In der Theiß-Marosecke ist die Saat im allgemeinen wegen Hitze und Dürre zurückgeblieben, schießt jetzt in Aehren. Vielfach ist jedoch die Saat schütter und niedrig. Insekten- und Brandschaden melden die Komitate Torontal und Arad. In den Komitaten jenseits des Königssteiges begehrt die Sommergerste den Regen schon sehr, bebuscht sich nicht, ist schütter, beginnt, Aehren zu schießen. Die gesamte mit Gerste bebaute Fläche wird auf 1898865 Katastraljoch, der Durchschnittsertrag auf 6.76 Doppelzentner vom Katastraljoch geschätzt. Sollte Regen bezeiten eintreffen, dürfte ein Gesamtertrag von 12.83 Millionen Doppelzentner Gerste zu erwarten sein, gegen 13.73 Millionen Doppelztr. im Vorjahre.

Rotterdam. Gerste liegt schwach. Schwimmende 59 bis 60 Kilo Odessa wurde zu 148 fl. und ladende 59 bis 60 Kilo Taganrog zu 146 fl. abgegeben; auf August-September-abladung kamen einige Abschlüsse in 59 bis 60 Kilo-Ware Asoff-Schwarzmeer zu 131 fl. vor.

Schweinfurt. Bei recht warmem Wetter waren die Zufuhren am Markte ganz ohne Bedeutung. Der Saatenstand berechtigt vorerst zu den schönsten Hoffnungen, wenn sonst nichts dazwischen kommt. Die Stimmung ist im allgemeinen ziemlich lustlos, und wird meistens nur der nächste Bedarf gedeckt. Die Vorräte werden allerdings immer kleiner, sodaß immerhin Aussicht besteht, daß sich die Preise halten. Futtermittel werden von auswärts stark angeboten. Notierungen: Gerste 20 bis 20.50 M., Hafer 17 bis 17.50 M., Malzkeime 11.50 bis 12 M., Gerstenschrot 13 bis 14.50 M., Maisfuttermehl 16.50 bis 17 M. für 100 Kilo.

Theodor Eilrodt.

Straubing. Der Stand der Winter- und Sommersaaten ist ein ausgezeichneter; wenn nichts dazwischen kommt, haben wir eine gute Ernte zu erwarten. Daß unter solchen Umständen jede Anregung zu Unternehmungen fehlt, ist klar, und nur dem Umstande, daß die Vorräte stark abnehmen, ist es zuzuschreiben, daß sich die Preise zurzeit noch auf ihrer Höhe halten können. Hafer notiert 17.50 bis 18 M. für 100 Kilo, frei Bahn hier.

Kohlenmarkt.

Essen. Der amtliche Kursbericht der hiesigen Börse vom 4. Juni verzeichnet für Kohlen, Koks und Brikette folgende Preisnotierungen des Rheinisch-westfälischen Kohlensyndikats für die Tonne ab Werk: I. Gas- und Flammkohle: a) Gasförderkohle 12.50 bis 15 M., b) Gasflammförderkohle 11.50 bis 12.50 M., c) Flammförderkohle 11 bis 11.50 M., d) Stückkohle 13.50 bis 14.50 M., e) halbgesiebte 13 bis 14 M., f) Nußkohle, gewaschenes Korn I und II 13.50 bis 14.50 M., do. III 13 bis 13.50 M., do. IV 12 bis 12.50 M., g) Nußgruskohle 0 bis 20/30 Millimeter 8.50 bis 9.50 M., do. 0 bis 50/60 Millimeter 9.50 bis 11 M., h) Gruskohle 7 bis 9.50 M.; II. Fettkohle. a) Förderkohle 11 bis 11.50 M., b) bestmelierte Kohle 12.50 bis 13 M., c) Stückkohle 13.50 bis 14 M., d) Nußkohle, gewaschenes Korn I 13.50 bis 14.50 M., do. II 13.50 bis 14.50 M., do. III 13 bis 14 M., do. IV 12 bis 13 M., e) Kokskohle 12.25 bis 13.25 M.; III. Magere Kohle: a) Förderkohle 10 bis 11 M., b) do. melierte 11.25 bis 12.25 M., c) do. aufgebesserte, je nach dem Stückgehalte, 12.25 bis 14 M., d) Stückkohle 13 bis 15 M., e) Nußkohle, gewaschenes Korn I und II 14.50 bis 17.50 M., do. III 16 bis 19 M., do. IV 12 bis 13.50 M., f) Anthrazit Nuß Korn I 18.50 bis 19.50 M., do. II 20 bis 23.50 M., g) Fördergrus 9.50 bis 10 M., h) Gruskohle unter 10 Millimeter 6.50 bis 8.50 M.; IV. Koks: a) Hochofenkoks 16.50 bis 18.50 M., b) Gießereikoks 19 bis 21 M., c) Brechkoks I und II 21 bis 24 M.; V. Brikette je nach Qualität 11.50 bis 14.25 M.

Mannheim. Während der jüngsten Zeit konnte man auch weiter die Wahrnehmung machen, daß die Zufuhren an dem süddeutschen Markte sich nicht in dem Rahmen hatten, den man angesichts der vorhandenen Möglichkeit bezüglich unbehinderter Beförderung infolge günstigen Wasserstandes hätte erwarten sollen. Die Vorräte in Süddeutschland sind so beschaffen, daß heute von keiner Sorte große Bestände vorhanden sind. Um so mehr sollte jetzt darnach getrachtet werden, große Mengen anzustapeln, um während der Verbrauchszeit gewappnet zu sein. Jetzt freilich sind die Anforderungen, die an den Markt gestellt werden, nicht belangreich. Durch diese werden aber immerhin die Ankünfte aufgezehrt, sodaß kaum merkliche Mengen auf Lager geworfen werden können. Das Angebot englischer Kohlen wird mit jedem Tage dringender. Dabei muß freilich auch der Umstand in Betracht gezogen werden, daß zur Lagerung bedeutender Mengen dieser ausländischen Ware die erforderlichen ausgedehnten Lagerplätze fehlen. Um nun die überschüssigen Mengen englischer Kohlen leichter an den Mann zu bringen, werden augenblicklich für diese Herkünfte zum Teil sehr niedrige Preise gestellt. Dadurch soll eben die Kauflust gehoben werden. Anders sieht es indessen mit den Preisen der Ruhrkohlen aus, welche ihren seitherigen hohen Stand behaupten.

Fragekasten.

Dieser Fragekasten bezweckt einen Austausch der Meinungen unter den Lesern. Fragen nach Bezugsquellen und Reklamen können keine Aufnahme finden. Die Redaktion lehnt jede Verantwortlichkeit für den Inhalt der gestellten Fragen sowohl als auch der erteilten Antworten ab, dieselbe fällt vielmehr den Einsendern zu. Einsendungen aus den Kreisen der verehrlichen Leser zur Beantwortung der veröffentlichten Fragen sind jederzeit willkommen. Fragen werden nur von Abonnenten angenommen, weshalb die Beifügung der letzten Abonnementsquittung notwendig ist. Fragen, welchen diese Abonnementsquittung nicht beigefügt ist, haben auf keinerlei Berücksichtigung zu rechnen.

Nr. 5158. (Verpflichtung zur Bierabnahme einer Brauerei von einer anderen.) Wir haben einen Bierlieferungs-Vertrag abgeschlossen, inhaltlich dessen bei freiwilligem oder zwangsweisem Verkauf des Wirtschaftsanwesens der Rechtsnachfolger des derzeitigen Kontrahenten verpflichtet ist, Bier von der Vertragsbrauerei bis 1911 zu beziehen. Das Anwesen gelangt in den nächsten Tagen zur Versteigerung, und es wird wahrscheinlich eine auswärtige Brauerei das Anwesen ersteigern. Wird dadurch obiger Vertrag hinfällig, oder kann die Brauerei verpflichtet werden, bis 1911 Bier von uns zu beziehen? Für rege Beantwortung herzlichen Dank.

W. R. in R.

Antworten:

Ihre Ansicht, den Rechtsnachfolger dessen, der mit Ihnen den Bierlieferungsvertrag abschloß, treffe eine Verpflichtung, ist eine irrige. Nach Art. 4 des Gesetzes vom 9. Juni 1899 (Bayern) haftet nur der Inhaber der Wirtschaft, und zwar nur dafür, daß er zu sorgen hat, daß sein Rechtsnachfolger in den Vertrag eintritt. Nun wird aber auch noch das Anwesen der Zwangsversteigerung unterstellt. Daraus aber muß man schließen, der Inhaber sei unvermögend, Sie zu befriedigen. Doch auch das subhastierte Grundstück bietet Ihnen keine Gelegenheit zur Erhebung eines Anspruches, weil Sie durch die Forderung aus dem erwähnten Vertrag auch noch lange nicht zu den Beteiligten bei der Zwangsversteigerung zählen. (Reichsgesetz vom 24. März 1897, § 9.) Hätten Sie aber vorher eine Sicherungshypothek (§§ 1185 und 1191 des Bürgerlichen Gesetzbuches und für Brauer Art. 14 des Bayrischen Ausführungsgesetzes zum Bürgerlichen Gesetzbuch) erwirkt, dann könnten Sie bei der Zwangsversteigerung mitreden; ob Sie aber Befriedigung dabei erhielten, das würde immer noch von der Höhe des Versteigerungserlöses abhangen.

W. K. M.

Ist alles richtig abgeschlossen, so dürfte es wohl keinen Zweifel wegen der weiteren Bierlieferung geben; enthält aber der geschlossene Vertrag etwa anfechtbare Punkte, so fragen Sie am besten einen tüchtigen Rechtsanwalt in dieser Sache, wie Sie sich eventuell zu verhalten haben.

R. in M.

Warum sprechen Sie denn nicht mit Ihrem Rechtsanwalt? Bei solchen Verträgen richtet es sich immer nach dem Wortlaut, und es läßt sich deshalb aus der Ferne nie ein Urteil abgeben.

H. Trapp.

Das ist jedenfalls eine Bestimmung, die doch gar nicht durchzuführen ist, wenn der Käufer nicht will. Wenn Sie eine Wirtschaft kaufen, so werden Sie sich doch nicht nach den Verträgen des Vorbesitzers zu richten haben, denn dann könnte man ja seinen Absatz stets sichern, indem man eben solche Verträge auf verschiedene Jahre hinaus mit allen seinen Kunden abschließt, vorausgesetzt, daß sie auf den Leim gehen. Haben Sie Geld in der Wirtschaft, dann wäre ja die Sache anders, aber auch nur so lange, bis Ihnen der Käufer das Geld zurückzahlt. Wenden Sie sich an Ihren Rechtsanwalt.

H.

Das sagt ja schon der Vertrag, der durch die Versteigerung nicht hinfällig wird. Die Brauerei mußte bis zur festgelegten Zeit das Bier von Ihnen beziehen.

Erich Wetzel.

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Nr. 5159. (Aufstellung einer Kühlmaschine.) Wir beabsichtigen, neben unserer Kohlensäure-Kühlmaschine, System Haaß & Littmann, eine zweite Kühlmaschine aufzustellen. Empfiehlt es sich im Hinblick auf Betriebsersparnis, eine Kohlensäure- oder eine Ammoniakmaschine, kombiniert, und welches System, vielleicht Linde, zu wählen? Welches von beiden Systemen arbeitet auf die Dauer am billigsten?

H. B. G. in H.

Antworten:

Stellen Sie doch ebenfalls eine Kohlensäuremaschine auf. Arbeiten gleich billig. **H.**

Machen Sie mir genaue Angaben über die Größe Ihres Kellers, die Größe der jetzigen Kühlmaschine, ich werde Ihnen dann die Vorteile und genaue Berechnung einer Schwefligsäuremaschine übermitteln.

H. Trapp.

Zwecks Vergrößerung der vorhandenen Kühlmaschinen-Anlage dürfte in Hinsicht auf Betriebskosten-Ersparnis, Anlagekapital, leichte Bedienung usw. die Abdampf-Eis- und Kühlmaschine, Patent Osenbrück, entschieden zu empfehlen sein. Dieselbe bedarf zu ihrem Betriebe keine so bedeutende Kraft wie ein Kompressor, sondern wird, wie der Name schon sagt, durch Abdampf betrieben, und zwar kann hierzu derjenige der Betriebsdampfmaschine, nachdem er die Wärmereserven bereitet hat, benützt werden. Außer der kleinen Ammoniakflüssigkeitspumpe kommen keine beweglichen Teile in der Anlage vor, sodaß Abnützung und Wartung als äußerst minimal zu bezeichnen sind. Der bei Kompressionsmaschinen häufig eintretende Uebelstand des Verschmutzens der Generator- und Kondensatorröhren durch mitgerissenes Oel kommt bei dem vorgeschlagenen Kühlmaschinen-System nicht vor, weshalb diese Maschine auch für immer ihre anfängliche Leistungsfähigkeit behält. Jede weitere Auskunft erteilt bereitwilligst W. Stange, Technisches Bureau in Stettin.

Schon allein die Tatsache, daß die Kühlmaschine System Linde in Bezug auf Verbreitung einzig dasteht, spricht für deren Güte und Brauchbarkeit. Fordern Sie Garantien und vergleichen Sie diese gegenseitig, so erhalten Sie schon einen Ueberblick. **Erich Wetzel.**

Welche Systeme am billigsten arbeiten, können Sie durch Einholen von Offerten verschiedener guter Spezialfabriken bald feststellen. Neuerdings sollen sich in der Praxis die nach patentiertem Verfahren hergestellten Abdampf-Eismaschinen gut bewährt haben und sich im Gebrauch äußerst billig stellen.

R. in M.

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Nr. 5160. (Verkauf einer Malzfabrik.) Wie berechnet man sich bei dem Verkauf einer Malzfabrik den Zentner Malz? Um recht zahlreiche Beantwortung wird höflichst gebeten.

W. in B.

Antworten:

Ohne nähere Angaben ist auf die kurze Frage schwer zu antworten. Im allgemeinen rechnet man 5 bis 7 M. für den Zentner Malz.

F. Martin, Braumeister der Lehr- und Versuchsanstalt für Brauer in München.

Darüber herrschen wohl geteilte Ansichten; Herstellungspreis sollte ausschlaggebend sein.

Z. in M.

So hoch, wie es eben geht, ohne den Käufer zu übervorteilen.

H.

So mit wenigen Worten läßt sich das nicht sagen. Dabei spielt ja alles mögliche mit: Rohprodukt und sein Preis, Löhne, Kohlen, Wasser, Abschreibungen, Zinsen und der jeweilige Preis des Malzes. Wollen Sie die exakte Berechnung abkürzen, um nur

HOPS

The hop plant was cultivated in Europe long before the first colonists from England and Holland crossed the Atlantic to find new homes in America. Some of the early settlers of New England had learned the culture of the hop and its use in brewing in their native country, and it was not long after their arrival before this plant was seen to be growing thriftily on some of the pioneer farms near the present city of Boston. For many years the hop industry centered in Massachusetts and Vermont but after 1800 it gradually spread westward, first to New York where it is still of some importance and finally to the Pacific Coast States which in recent years have produced most of the hops grown in this country.

The hop (Humulus lupulus) is a perennial plant of the nettle family. The roots live over from year to year and each spring send forth a number of long, rough, twining stems or vines. Near the root the stems bear opposite, rough, lobed leaves, but on the upper part of the plant the leaves are alternate and entire. In midsummer the main stems put forth many slender branches called arms on which the flowers are borne. The staminate (pollen producing) flowers and the pistillate (seed producing) flowers occur on separate plants. The pistillate flowers are clustered in short catkins with thin, concave, entire scales or bracts which greatly increase in size as the fruit ripens, the whole forming a cone or strobile. Many small, yellowish granules, called lupulin, are formed at the base of each bract. These granules contain an aromatic resinous substance which gives a distinctive taste to beverages in which hops are used. The ripened cones which are

generally known under the name of hops form the marketable product of the hop plant.

The hop plant grows wild in many parts of Europe, in southern Siberia and in the middle portions of North America. It is often found along streams in the upper Mississippi Valley and eastward to New England. The principal foreign countries in which hop growing is an important industry are Germany, England, Czechoslovakia, Russia, France and Belgium. Hops can be grown throughout the United States and in southern Canada except in very arid regions or in mountainous districts subject to summer frosts. In the Southern States hops are not produced commercially but are frequently grown on a small scale for domestic use or as a decorative plant on porches, fences and trees. Hop culture has been abandoned in many states where it was once apparently successful on account of the lower cost of producing this crop in other localities. Its commercial production is now restricted to Oregon, California, New York and Washington.

Well-drained, rich, alluvial lands or deep sandy or gravelly loams are preferred for hop raising. The ground is usually deeply ploughed and well pulverized before planting. Hop plants may be grown either from seed or cuttings, called "roots" or "sets," which are taken from the creeping rootstocks sent out by the plant a few inches below the surface of the ground. Roots only are used in practical culture since they produce strong thrifty plants more quickly than seed. Seedlings are chiefly useful in developing new varieties. The roots are planted in hills, spaced 6 to 7 feet apart, in long straight rows made 7 to 8 feet apart.

Since the hop is a climbing plant some artificial means of support must be provided when it is grown as a cultivated crop. Many different kinds of support are used. A common practice in New York State is to set to each hill one or two slender poles, usually from 14 to 18 feet long. Stout strings are attached to the middle of each pole and carried to the tops of the ones adjacent to it where they are fastened. A support called the wire trellis is used on the Pacific Coast. Large posts 20 feet long are set at every sixth or seventh hill each way across the field. Over the tops of these posts heavy wires are stretched across the field each way at right angles. A smaller wire is stretched over each of the rows in which there are no posts and securely fastened to posts set at the ends of these rows. The wires running over the rows are also fastened to the cross wires at right angles to them and strings leading up to them from each hill support the vines.

The hop plant is subject to injury from a number of diseases and pests. Some of the insects most destructive to the plant are a mite called "red spider" and the hop flea-beetle in the Pacific Coast region; the hop-vine borer and the hop redbug in New York State; and the hop aphis, a pest wherever hops are grown. The leaves and tender parts of the vine are most subject to attack. The extensive use of insecticides, many of which are applied in the form of sprays, is an expensive but necessary part of hop culture. The only fungous disease of hops that is of much importance in this country is a mildew frequently spoken of as "blue mold." It is only in New York State that it causes serious damage. Hop mildew attacks the vine, leaves and flowers. Dusting the plant with flour sulphur is a common remedy.

Another fungus, which hop growers call "black mold," grows in the honeydew excreted by hop aphides and frequently coating the entire surface of the leaves and cones. The presence of this fungus on hops gives them a soot-covered appearance and makes them unsalable.

Hops are usually harvested between August twentieth and the middle of September. If the crop has been grown on poles the vines are cut about three feet from the ground, the pole pulled up and with its load of vines rested on a low support within easy reach of the pickers. If grown on wire trellis, the strings which support the vines are broken or cut at the point of attachment fo the overhead wires thus allowing the vines to fall to the ground. Often the overhead wires are lowered to bring the vines within reach. The hops are removed from the vines by hand and thrown into boxes or baskets from which they are emptied into large burlap sacks holding 50 to 90 pounds and immediately taken to the kiln to be dried.

The drying house or kiln is usually a large square wooden building with a single floor placed about twenty feet from the ground. On this floor which is made of slats and covered with a carpet of heavy burlap, the hops are spread evenly in a layer from 14 to 30 inches deep. The air beneath the drying floor is heated to about 120° F. by a furnace or huge stoves and rising between the slats passes through the hops and carries off the moisture from them in from 12 to 20 hours, leaving them dry and brittle. The hops are bleached to a uniform yellowish color by means of the fumes of sulphur a quantity of which is burned beneath the drying floor in the early stages of drying. When drying is finished the hops are

removed from the kiln and stored in a separate building until they are ready for baling.

Hops are prepared for market by pressing into bales measuring about 20 by 24 by 52 inches and weighing from 180 to 200 pounds. Each bale is enclosed in a stout covering of jute bagging which preserves the shape of the bale and protects the hops from injury while on the way to market.

W. W. Stockberger.

Nov. 28, 1923.

1 2 3 4 5 6 7 8 9 10 11 12 13

plants proportionately longer.

IMPROVEMENT OF HOPS BY SELECTION AND BREEDING.

By Dr. W. W. Stockberger, *U. S. Department of Agriculture, Washington, D. C.*

NEED FOR IMPROVEMENT.

The improvement of the common hop by selection and breeding has received some attention in Europe during the past fifteen years, but, unfortunately for the best interests of American hop growers, it has been practically neglected by them in the United States. In years favorable to the harvesting of a large crop it usually becomes expedient to export from one-sixth to one-third of the total production, thus bringing American hops into sharp competition with those grown in Europe, the larger portion of which, particularly those grown in Austria and Germany, has the reputation of being far superior in quality. An appreciation of this discrimination on the score of quality and the recognition of the desirability of producing a superior American hop to successfully compete in our home markets with those of high grade now imported from Bohemia and Bavaria, has recently induced growers in various sections of this country to plan for the improvement of their crops by systematic selection or by breeding improved varieties.

FAILURE OF INTRODUCED VARIETIES.

Numerous attempts have been made by various growers to introduce the better varieties cultivated in Europe, but so far the results have not been encouraging. In some cases after three or four years' cultivation the vines from the imported cuttings have not come into bearing, and in the others, where some hops have been produced the yield was too light to enable the grower to pay the cost of production. As a consequence yards of from 2 to 10 acres set with imported varieties have been plowed up and reset with

local American varieties. On the Pacific Coast, plants raised from cuttings of certain English varieties brought first to British Columbia and thence taken to California exhibit much the same tendency. These experiences show that varieties of the hop plant are influenced to a marked degree by soil and climatic conditions, and indicate that the most successful results may be obtained by selecting and breeding each strain in the locality where the regular crop therefrom is to be grown.

IMPROVEMENT BY SELECTION.

It would appear that the first important step for the hop breeder is a careful study and test of various varieties in order that he may select those which give the most satisfactory results and which are best suited to the conditions of soil and climate in the locality in which the work is being done. While the number of existing varieties of hops is not large it is sufficient to make a wide range of selection possible. In New York State are varieties known as Palmer Seedling, West Seedling, Humphreys, English Clusters, Canada Redvine, Grape, and Spaulding Early Cluster; in western British Columbia are cultivated English Clusters, East Kent Goldings, Canterbury Goldings, Canterbury Whitevines, Cobbs, Fuggles, Bramlings, and Early Bird, several of these varieties being also common in Washington and Oregon. In California, soil, climate and cultural conditions have caused wide variation so that growers believe that they have many local varieties for which they have no names. The varieties recognized are the Red Vine or San Jose, Golden Cluster, and Early Bird. The two latter afford a striking example of the differences which may exist between varieties. I have in mind two adjacent farms the soil and cultural conditions of which are very similar; one of these has 112 acres planted with the Golden Cluster variety, and the other has 110 acres set with the Early Bird. For a number of years the farm with the Clusters has produced each season about 200 bales more than the other. Aside from yield other differences, such as time of ripening, size of cones, color, aroma, tendency to put out runners, vigor and habit of growth are very apparent.

The second step in the improvement of hops, after the selection of promising varieties, is the selection of individual plants. Positive results have been obtained in Germany by Fruwirth, who made comparative tests of plants grown from cuttings taken from heavy bearing plants and those whose roots were selected from light yielders. The outcome of his experiments shows that the former are distinctly superior in yield. In these trials advantage was taken of the great variability which exists among the plants of every field even when they are all apparently of the same variety. The plants of every field also vary widely from the type of the sort, which variation may be due either to impurity of variety, fluctuating variability, or to bud variation. To the latter is accredited with more or less certitude the origin of several important sorts of varieties such as

the Early Brambling, Golding, Humphry, and Semsch, although in most cases it seems equally probable that the new forms arose from chance seedlings.

At previous meetings of this Association several practical plant breeders have called attention to the frequent waste of time and labor involved in neglecting the possibilities of selection in the endeavor to reach the desired ends by breeding, when the parent varieties had not been purified by selection, or when the qualities desired already existed in certain strains or races. These warnings cannot be disregarded by the hop breeder when it is remembered that there is probably not one American variety of hops which is pure. Breeding by hybridizing under these conditions can only lead to confusion, but selection should yield immediate and definite results. Two of the several courses which are open are (1) the repeated selection of superior plants, or (2) the selection of seedlings grown from seed taken from a field in which the plants have a high degree of uniformity. If the number of seedlings is sufficiently large there should be a good chance of finding one or more which will have the desired characters of superiority and excellence. By continued propagation by the usual method of making cuttings the new sort may be at once fixed and introduced into cultivation.

The number of seedlings or the number of selections necessary to attain the desired result is problematical, but safety here certainly lies in large numbers. Last summer the writer secured the collection of over a million hop seeds and arrangements have been made for planting them this coming spring. From the seedlings thus to be obtained the most promising will be chosen for future study. This will serve at the least as a beginning in the improvement of the American hop by selection.

IMPROVEMENT BY HYBRIDIZING.

Hybridizing or cross-breeding logically follows thorough and systematic selection, and in my judgment should be attempted only after very careful study of existing varieties. There is much work to be done in sorting out and classifying the different sorts or strains and in distinguishing the characteristics or qualities which are the result of environmental conditions from those which are hereditary and permanent. Also a considerable fund of knowledge concerning correlation of characters, particularly those which have been termed by Dr. Webber physiological correlations will be advantageous to the breeder. Because of the conditions of seminal reproduction in the hop the expenditure of time and labor in producing new individuals by crossing is necessarily very great. It is, therefore, of primary importance to first become acquainted with the best varieties, to learn their adaptability to the soil and climate of different localities and to observe their performance under those conditions, in order to choose for new combinations the highest existing types. The regular work of breeding may

then begin and it presents no technical difficulties in the way of producing valuable new hop sorts.

Certain advantages as well as some disadvantages are presented by the situation of the sexes on different plants. The female plants only are of commercial importance, and what has been said with regard to varieties applies to them alone. The male plants are apparently somewhat less subject to variation, and no attempt has ever been made to distinguish varieties among them. The difficulty of securing a purebred male parent is at once evident, and it is apparent that purebred seed is therefore at present unobtainable. Close examination reveals some variation in structure, vigor of growth and time required for the maturity of the male plants, and they should be used in crossing only after rigorous selection has eliminated all which in time of maturing pollen and in suitability of other characteristics do not accord with the plants selected for the female parents. The hop is naturally wind pollinated and the enclosing of the artificially pollinated flowers in pedigree breeding is absolutely essential. Even isolated plat breeding will give very unreliable results owing to the access of foreign pollen which is practically certain to be carried by the wind from afar. There are a number of authenticated cases of the self-fertilization of female hop plants situated a number of miles from the nearest males.

It seems probable that the unusually great variation exhibited by hop seedlings is in part due to repeated inter-crossing of varieties, but the fact that existing varieties of hops have been profoundly modified by local conditions should not be lost to view; in fact, owing to the usual method of propagation, many of these, upon careful study, will no doubt prove to be clonal varieties.

So great is the variability of seedlings that seed propagation is not employed in regular agricultural practice, the increase of plants being secured through cuttings. Approximately one-half of the seedlings will be males, and they cannot be recognized with certainty until flowering time, which cannot be less than two and maybe three years from the seed. Under the most favorable conditions four, and if the plants are permitted to reach full maturity at least six years must elapse before second generation hybrids can be obtained, but from the observed fact of great variability in seedlings, it is apparent that those of the first generation vary sufficiently in their characters to permit of advantageous selection. Thus much valuable time will be saved, as a seedling of the desired type can be readily propagated by cuttings and multiplication, for a very few years will suffice to produce thousands of new plants. Since variation following this method of reproduction is very restricted a high degree of permanence is at once secured for the new type.

CORRELATION OF CHARACTERS IN THE HOP.

The study of the correlations in the hop, as in biennials and other perennials, is of very great value to the hop breeder. Al-

though our knowledge of these correlations is not extensive certain relations between different varieties are sufficiently well understood to make possible the early rejection of plants of no value for breeding purposes as well as those whose general unsuitability for the conditions of cultivation render them undesirable. In the work of practical breeding a correlation which will serve to indicate the sex of the seedlings in their first year of growth will be of immense advantage. Among the Japanese laborors in the hop fields of the Pacific Coast the occurrence of a faint reddish or pinkish ring around the vascular axis of the root is regarded as indicating a male plant. Although I have apparently confirmed this opinion by a number of independent observations, I am still skeptical as to the reliability of such a test. It is mentioned here more particularly as suggesting the possibility of finding valuable correlations between internal structure and other characters.

Certain general correlations are fairly well established and will probably be found to hold good for most varieties. The following list of correlations which includes the observations of a number of investigators comprises the cases of especial interest: Early ripening usually associated with low yield, late ripening with high resin content, strong aroma with aboundance of lupulin, large yield with coarse aroma and large strobiles, large dark green strobiles with low tannin content, compact hairy spindle and small narrow bracts with fine quality, reddish vines with earliness and susceptibility of disease, and green vines with productiveness.

The degree of correlation is quite variable in the different varieties, and characters very closely related in some sorts are apparently entirely independent in others, a relationship which has been observed by East in sugar beets and corn. Further observations will no doubt reveal other correlations, and those which may serve to distinguish plants of high quality in the early stages of their growth will be the most valuable.

THE IMPORTANCE OF BREEDING IN HOP CULTURE.

Notwithstanding the emphasis which has been laid upon selection, the importance of breeding in hop culture is by no means underestimated. When by selection pure varieties having definite desirable characters have been obtained it will be the work of the breeder to produce therefrom new combinations. In this way it may be possible to unite in one plant the fine aroma of the famous Saaz hop with the thriftiness of growth and the productiveness of our local varieties.

For the two seasons just past certain plants in various hop-growing sections have been observed which manifested distinct disease-resistant tendencies. These plants are now being carefully propagated and, if this character proves transmittable, the possibility is opened through suitable breeding to immensely improve the existing conditions with respect to attacks of certain diseases.

Since the hop is propagated asexually it may well be that each strain or sort tends to become thereby constitutionally weakened and hence more subject to disease and unfavorable environment. The interpolation of sexual generations through the process of breeding would then operate to overcome this tendency and to result in increased vigor and resistance.

Not to go into further details some important characteristics which it is desired to secure in an increased degree in new races of hops, and which may be best attained through the application of the principles of breeding, are quality, vigor, resistance, and productiveness. Concerted action on the part of careful and thoughtful breeders working toward these ends through composite breeding should produce races of American hops which will successfully compete with those of European origin.

THE FIELD FOR ECONOMIC PLANT BREEDING IN THE COTTON BELT.

By David R. Coker, *Hartsville, S. C.*

BACKWARDNESS OF THE SOUTH.

In considering any subject related to the present condition of southern agriculture, it is well to remember that our section has not completely recovered from the effects of the Civil War and the ensuing period of negro rule. This cannot but be plain to the student of southern agricultural conditions, and it is largely caused by the almost complete paralysis of our educational system during and for some years after the war.

A large percentage of our farmers, not having had the opportunity to obtain an education, have been unable to keep full pace with the advance of their profession. The influence of our Agricultural Colleges and the missionary work of such men as Dr. J. M. McBryde, Col. J. S. Newman, Prof. W. F. Massy, Mr. E. McIver Williamson, and Editors Jackson and Hunnicutt are, however, plainly evident in the general and rapid improvement of conditions.

Though great advances along many lines have been made, the subject of plant breeding and its vital relation to agriculture has hardly begun to attract attention in our section. Scarcely any of our farmers have the slightest conception of what plant breeding means, and there is now almost no supply of pedigreed seed of any of our staple crops. Our farmers, however, can be counted on to buy scientifically-bred seed and devote some attention to seed selection, as soon as the great value of pure breeding is impressed upon them. Our Agricultural Colleges and farm journals have a great field for missionary work on this subject, which, as yet, they have scarcely touched.

PAPER READ AT A MEETING OF THE AMERICAN BREWING INSTITUTE, HELD AT THE CHEMISTS' CLUB, NEW YORK CITY.

p. 21-3

Improving the Quality of Domestic Hops.

By Dr. W. W. Stockberger,

United States Department of Agriculture,

Washington, D. C.

Probably no question regarding the production of an agricultural crop is to-day receiving more attention than that of specific crop improvement. The facts accumulated by observation and experience during past years are being reviewed in the light of increased knowledge gained by the study and application of broad scientific principles. The men of to-day are witnessing the passing of the widespread belief that the production of new and improved varieties of cultivated plants is a process accompanied by much mystery, and to be accomplished only by those possessing some magical power over the laws of nature. With the passing of this belief comes the knowledge that the laws of nature governing the production of larger, stronger, and better varieties of plants, while as yet very imperfectly understood, are still capable of very successful application at the hands of every careful and thoughtful agriculturist. As evidence in support of this statement may be cited, the improved strains of practically all the cereals besides forage plants, fruits, and vegetables which have been developed during recent years. These improvements have been made along different lines; in some strains resistance to disease, cold or drouth has been developed; in others finer quality, more pleasing flavor, or greater content of some valuable constituent. It must be frankly admitted that with all this progress in improving agricultural plants the hop has been practically neglected. Although in value it ranks fourteenth in the list of agricultural crops of the United States, the attempts which have so far been made to improve it have either been sporadic in nature, or conducted on so small a scale that they have had no effective bearing on the industry at large. It is an optimism certainly justifiable which predicts that in the domain of hop culture as broad opportunities exist for development and improvement along the lines just indicated as in that of any other cultivated plant.

The question of first importance in undertaking the amelioration of the hop plant is the establishment of an ideal—a criterion of quality or value which shall serve as a guide to

the agriculturist in his efforts toward improvement. The lack of an adequate and satisfactory standard of quality is largely responsible for the prevailing loose and indefinite ideas among hop growers as to the characteristics of a hop of high quality. In a large measure the standards of the farmer have been derived from the local dealers to whom he sold his crop, or from traditions existing in the community in which he lives.

In determining the quality of marketable hops each consumer has been a law unto himself with the frequent result that individual preference instead of intrinsic value decides the choice. Thus it actually occurs that a hop rejected by one consumer will be readily purchased by another, a state of affairs which is directly responsible for the sentiment sometimes voiced among hop growers that "No matter how inferior the hops may be, some one will be found who will buy them." Also, growers have justly complained that the man who did, by extra labor and expense, aim to produce a higher quality of hops received no better price for them than the grower whose maxim apparently is "Quantity not quality."

As a result of this attitude of mind the hops produced often vary greatly in their value to the consumer, and very frequently the general average falls far short of the standard of excellence which might be reached were the proper attention given to certain practical principles of hop production which should be a matter of common knowledge among all hop growers. The knowledge that the real merits of his hops would be determined by standard methods of valuation would furnish the strongest incentive to the grower to strive to increase the worth of his product.

It is a sign of hopefulness that among the more progressive hop growers there is to-day a manifest desire to obtain and to utilize all available knowledge concerning the better culture of the hop plant and the means of producing hops of superior quality. However, no sooner does the farmer grasp the possibilities which are open to him in the direction of improvement of the hop plant and its product than he very naturally seeks for exact standards of valuation from which he may determine the deficiencies in the quality of his crop, and which will give him an ideal or a definite objective point towards which he can aim in his efforts to produce a hop better suited to the requirements of the consumer.

This question of a uniform standard for the valuation of hops is by no means a new one, and, as is well known, presents a series of difficult and unusual obstacles. In fact judgments of value based on physical qualities alone seem uniformly to

differ so systematically from those made by the chemist after his examination that many have been led to regard as futile any attempt to promulgate a scheme for the exact analysis or estimation of the value of hops. Nevertheless, this question which lies at the very beginning of progress in hop culture for both agriculturist and technologist must be solved if only in a tentative manner, for under existing conditions it is not always easy to put analytical results obtained by one technologist in comparison with those of another, and it is usually difficult indeed to draw from these results inferences which may serve as valuable guides to the agriculturist in so manipulating the culture of the hop plant that the undesirable characteristics will be diminished and the desirable and useful ones augmented. The splendid results attained by the analysis committee of the United States Brewers' Association in formulating a scheme for the analysis of malt should serve as a stimulus and an encouragement in attacking this problem. Every one knows what serious obstacles stood in the way of this committee and how very important were the final results of their researches. That in a similar manner success will attend the efforts to secure the formulation and adoption of a uniform method for the evaluation of hops may be regarded as assured by the action of the Society of Brewers' Chemists of the United States at its recent annual meeting. During the course of the deliberations of this Society the subject of hop analysis was fully discussed and an able committee was there appointed to investigate the methods of hop analysis and valuation with a view to devising some efficient means for standardizing hops. When this committee has finished its labors and has made its report another very important forward step will have been made in the development of the hop industry, for no one factor has so retarded progress in hop improvement as lack of agreement as to what constitutes quality and what are the elements entering into the constitution of a superlative hop. Contemporaneous with the work of this committee and perhaps logically a part of it should be the determination and publication in amplified form of the part played in the process of brewing by each of the useful constituents of the hop. The better understanding of these relations by that portion of the public at large which is economically interested in the hop industry should pave the way for more readily harmonizing the usually discordant results of physical and chemical examination with reference to quality, and at the same time clarify the vague ideas existing in the mind of the layman with respect to what gives the hop its brewing value. Once this is clearly

understood it becomes possible for the agriculturist to direct his efforts toward producing a hop containing the maximum quantity of these desirable principles. The probably great value of an accurate knowledge of the relation between mineral constituents and quality should not be overlooked. The hop plant absorbs from the soil large quantities of valuable ingredients which serve as plant food. The most important of these are potash and phosphoric acid, and from the tabulation of a number of available ash analyses of hops it appears that that this plant withdraws from the soil about three times as much potash and phosphoric acid as our commonly cultivated fruits and nuts, besides making a heavy demand on the supply of available nitrogen. From this it seems probable that the addition of fertilizers rich in these substances should restore the productivity of hop soils which have become depleted in fertility by long continued cultivation.

A question arises here as to the desirability of a high soluble salt content in hops which would be extracted in the course of boiling. It is well known that the flavor of tea is decidedly influenced by the nature and proportion of salts present in the water used for its extraction. Probably the nature of the water used is a matter of greater importance than the amount of soluble salts present in the hops, as illustrated in the cases pointed out by Dr. Wyatt in which water containing carbonates of lime and magnesia was used whereby too much hop resin was extracted thus imparting a coarse flavor to the beer. Also it is not impossible that the hop resin from hops grown under different conditions differs somewhat in constitution and solubility ad so affords an explanation for the reputation for rankness and coarseness of flavor from which some of our domestic hops suffer at present.

Many fertilizing experiments have been made but they are in large measure defective, as the weight of the hops harvested in many cases was the only point considered, no attempt being made to judge the quality. Nevertheless, the question of the mineral constituents of the hop offers a very wide field for observation and experiment, with some encouragement to the worker who attempts to increase the amount and quality of the valuable constituents.

We should also have a more complete understanding of the part played by the resins, bitter principles and volatile oil in the hop in order that their relation to quality may be constantly considered during the process of drying or curing on the kiln. It is quite generally conceded that the so-called soft resin of the hop alone is valuable, the hard resin being worthless for

brewing purposes, yet the average grower knows nothing of these resins and frequently contrives to dry his hops at a temperature so high that a portion of the essential oil is volatilized and a considerable quantity of the valuable soft resins is oxidized and converted into the hard worthless form. In a series of recent experiments in the field it has been shown conclusively that, within limits, the ratio of soft to hard resin depends directly upon the temperature used in drying the hops. There is here an opportunity for immediate improvement in the quality of hops since these resins are of signal importance, but until they are recognized in grading quality so that the man who carefully dries his hops will realize a higher price for them growers will be slow to try to increase the content of soft resin.

The aroma of hops is regarded as residing in the volatile oils, the definite properties or qualities of which have not yet been subjected to thorough-going investigation. The different varieties of hops differ in aroma, but as yet no one has characterized the differences in chemical composition to which the variations in aroma are probably due. Since the volatile oil is not a simple substance but rather a mixture of compounds, it is possible that the differences in aroma are due to the varying proportions in which the different constituents of the oils are mixed. Whatever may be the technical value of the hop oil the great dependence placed upon aroma in judging the value of hops suggests that in the composition of the oils should be found a measurable characteristic of quality. If the volatile oils from the hops of a number of different sections, which vary in reputation for quality or fineness of aroma, are found to constantly differ in their constitution in a manner directly related to the differences in aroma, it may be in order to assume that the reputed differences are well founded. However, should careful examination of these oils reveal no appreciable differences or show results at variance with accepted relations as to quality, it may become necessary to revise entirely our ideas concerning the value of this factor in determining the quality of hops. The great amount of labor and the not inconsiderable expense attached to any extensive study of the oil of hops has doubtless prevented chemists from attacking this problem more seriously. Some preliminary work on hop oils from different sources has yielded very promising results and an extensive comparative study of the relations of the volatile oil to quality in hops of different geographical origin has been planned and is now in progress.

With increased knowledge of the constituents of hops a wide field is opened for the study of the factors which influence the

formation and nature of these products. Relatively little is known about the effect of soil, climatic conditions, fertilizers, irrigation, or variety upon the oil, resins, bitter principles and tannin of the hop. There is here a great opportunity for much study and investigation which should produce results not only of scientific but of great practical value. When we can say to the hop grower that a certain variety of hops produces a more desirable quality of bitter or resin than another, or that a certain fertilizer or method of culture will give a higher yield of these constituents and hence make his product of greater value both to himself and to the consumer, then will we have, sure and definite, additional grounds for directing hop improvement.

The prevalence of lice and molds in hops is a constant menace to the consumer, and the occurrence of these pests likewise entails great loss to the hop grower. Some years ago these enemies were unknown in some hop-growing sections, but by degrees the areas, subject to their attacks, have enlarged, and now no region is free from them. In California, which was the last State to be infested, the yearly attacks are apparently becoming more severe and threaten serious loss to the industry in that region. It scarcely need be said that any means which will bring relief from this condition will be welcomed by all interested in securing hops free from disease and mold. Investigators have for some time devoted considerable attention to the cultivation of economic plants which are resistant to parasites and fungous diseases. Different plant varieties, and different individuals of the same variety, have been found to manifest varying degrees of susceptibility with respect to the attacks of certain pests. It is well recognized that certain varieties of the hop are more resistant to the attacks of lice and mould than others. By analogy from many cases among other cultivated plants we may expect to find certain individuals among the better varieties with constitutions resistant to the attacks of mold, and capable, further, of transmitting their immunity to their descendants. By careful and judicious selection, therefore, it seems probable that a strain or race of hops may be produced which will have a very high degree of resistance to mold, and so insure a crop in great measure at least free from this trouble. During the past season in some of the badly-molded yards of New York State, hills were found which were absolutely free from mold, although entirely surrounded by badly-molded hills. These hills have been marked, and cuttings will be taken from them next spring and used for propagating these resistant individuals. It is

certainly obvious to all that further work along these lines will form an important part of the movement to improve our domestic hops, and plans are being made for a considerable extension of this work whenever the means are available for its furtherance.

The principles of selection can be supplied for many other purposes than that of securing plants resistant to disease or other unfavorable growth conditions. Very important results may be attained in improving both quality and productiveness of the hop plant by these means. Every hop yard contains some plants which bear more heavily than others. New plants produced by cuttings taken from the plants of superior productiveness retain this important characteristic, which is transmitted unchanged to all the progeny of the first mother plant. Decided improvement, therefore, may be very readily made even though other characteristics than those of productiveness be considered, by the simple process of inspecting the plants in the field, making those which are evidently of better quality or more productive, and by using the cuttings from these choice plants alone for propagation.

From time to time plants occur in hop yards which vary to a remarkable degree from the average in time of ripening, color of the strobiles, yield, or some other qualities, and which have the property of transmitting their new character to their descendants. If the variation is small and inconstant it may be attributed to some accident of the surroundings of the plant, but a wide difference which is permanent and transmittable must be of the nature of a bud variation or sport. To bud variation is ascribed with more or less certitude the origin of several of our most valuable hop sorts. Although the history of their origin is discredited by some, there are good reasons for believing that such well-known varieties as the Early Brambling, Golding, Humphrey, and Semsch hop originated in this manner. One of these, the Humphrey, is of American origin, and according to tradition in Wisconsin, where it originated, a German woman, the wife of one of the early pioneers of the North-West, brought with her from Germany the root of a hop plant, from which this variety sprung. According to another account it originated from a choice seedling among the plants of a hop yard. Whatever its origin it has several qualities which make it attractive to the hop breeder, among which are earliness, vigor, and an apparent tendency at least in some localities to resist the attacks of aphis or plant lice and mold. This is but a single illustration of the several improved varieties which have arisen spon-

taneously and luckily attracted the attention of a keen observer who saw in them much of promise for the future. Every year these variations are occurring in almost every hop yard. Probably the vast majority of them are only small fluctuations and hence pass unnoticed. On the other hand, the significance of these modifications is practically unrealized by hop growers, although there are a few scattered cases in this country in which a successful selection of new forms has been made. A few years ago such a selection was made by Mr. C. H. Curtis, of Waterville, New York, and the new sort is being tested and propagated in his hop yards.

The extension of the idea of selection among the hop growers can not be accomplished by an academic presentation through the medium of the agricultural journal or other avenue of publication alone. Field demonstration of principles and results to be attained in various parts of the hop growing sections will be the surest method of enlisting the sympathies of the grower and directing his energies into a channel from which may flow a stream of results beneficial to the industry.

A consideration of the advantages to be gained through the process of selection of superior individuals must naturally take into account the important subject of the breeding of pure races, with which it is closely allied. The recent expositions of the methods of Dr. Nilsson and the splendid results which he has achieved in the production of new races of cereals has given a great impetus to movements for the production of better and purer races of cultivated plants in the United States.

Because of certain natural characteristics the hop is a plant particularly well adapted to the purposes of the plant breeder. The male and female flowers are borne on separate individuals, the latter alone forming the hops of commerce. The pollen from the male flowers is carried about by the wind or by insects so that in a yard where both male and female plants occur, indiscriminate hybridizing will take place naturally. The seeds produced as a result of this crossing will, when sown, give rise to seedlings which are strongly predisposed to variation, in fact they manifest this tendency to so great a degree that the hop grower rarely resorts to seed propagation to secure new plants. Other disadvantages of this method lie in the fact that approximately half of the seedlings will be males and hence useless for commercial purposes, and that three years at least are required to bring the plants into full bearing. Ordinarily, therefore, the hop is propagated vegetatively by root cuttings, by which means relative stability and uniformity of the new plants are secured, and the characteristics and

qualities of the mother-plant are transmitted with but little change.

The great variations occurring among the seedlings of any common variety of hops indicate that the variety in question is a mixture of many elementary and different types which differ as to their botanical marks and economic qualities. If these types are selected and propagated they will remain constant, thus forming new and pure races. In the seedlings are mingled characters derived from both male and female parents, some of which are dominant and give to the plant the pecular marks or qualities which distinguish it from others. Other parental characters are latent or recessive and do not visibly affect the appearance of the seedlings but will become manifest in a portion of its progeny. Upon the observation of these facts the method for obtaining pure pedigreed races is founded. By such races are meant those which have sprung from a single seed and in which by careful selection for a term of years all individuals which did not "breed true," i. e., transmit the parental characters unchanged, were rejected and destroyed. With the hop, when a pure race is once secured, it is easily maintained, since vegetative propagation is the rule, following which variation is very restricted.

Through the discovery of Mendel and the brilliant experiments of De Vries the laws of nature respecting the variation of which plants are capable are now in some measure understood, and their intelligent application is yearly increasing the importance and value of agricultural crops. The production of new races by hybridizing or cross-breeding and the possibilities for improvement which lie therein are beginning to receive the attention which their merit deserves. By this means a composite breeding can be effected whereby the desirable qualities of two or more individuals may be united in one plant. Thus in the case of the hop there is no apparent reason why the quality of fine aroma can not be combined with that of heavy bearing, earliness of ripening with richness of resins, or mild and pleasant bitter, good flavor and yield with disease resistence. Some of the qualities are purely morphological, as growth, yield, size of cones, etc., other are more properly termed chemical. It is no doubt futile to attempt to produce a plant which shall have all these characters developed to the highest degree, yet some of the most valuable of Burbank's productions have been secured by uniting in one plant, through repeated hybridizations, the superior qualities of a number of selected ancestors. Numerous other investigators have found that hybrids often excel both parents in the vigor of their growth and the abund-

ance of their flowering. At all events the union of characters which are correlated, that is those whose variation becomes the primary cause for the variation of another character, may be brought about within certain limits, and plants produced which will combine quality with quantity of production to a very favorable degree.

Experiments with the cereals and other agricultural crops have shown that some varieties are much better adapted to certain localities than others, and that the converse also is true. It is, therefore, very desirable to make a careful study of the suitability of each of the leading varieties of hops for the various conditions of climate, soil and culture in the various hop producing areas. Not only do the varieties vary in adaptability to various localities but strains or races within the variety show important differences in this respect. Frequently when cuttings are taken from one situation to another with different physical conditions the new plants springing therefrom are so changed in appearance from the mother plants that their relationship would not be suspected. The characteristic time of ripening and the yield, however, remain practically unchanged. This indicates that these characters are hereditary and transmittable, and that those which have undergone modifications in the new situation are probably environmental and subject to change whenever there is variation in the physical surroundings. After a plant has been cultivated for a number of years under a constant set of conditions it becomes adapted thereto and a minimum of variation may be expected, but when the plant or its offspring are placed under different conditions some modification more or less desirable is quite certain to follow. The change may even be harmful to the well being of the plant in which case it frequently becomes manifest in loss of vigor or productiveness. That these factors have not been considered in hop culture is evident from the current practice of indiscriminate distribution of cuttings without regard to variety, conditions under which grown or suitability of the new surroundings for the development of strong and vigorous plants.

The improvement of the standard of our domestic hop by the importation of cuttings from abroad, except for the purpose of obtaining new and superior strains to use in cross breeding, seems, therefore, to be impracticable. Consequently the most feasible method of increasing the merit of our American hop will be the origination of improved domestic varieties. A large proportion of our common fruits, vegetables and grains were formerly of foreign origin, but, either through divergence of form through conditions of environment or the production of

new varieties by seedings from the original stocks, the number of domestic varieties is now very great. Advantage may well be taken of the valuable data won through long experience with other agricultural crops, and the general principles derived therefrom must be given due consideration in any attempt to ameliorate our domestic hop.

Mention has already been made of the fact that for the private individual there is little incentive to undertake the improvement of the hop by cross-breeding because of the present conditions of methods of valuation, and the poor prospect of a direct and immediate financial return. It is because the improvement of the hop has been almost entirely left to private enterprise that so little progress has been made. But the matter is of such importance that it should not be left to private interests to carry out this work if it is to progress as rapidly as the economic interests of those dependent upon hop production demands. Associations and societies whose professional or business interest bears upon hop culture should share in this work and participate actively in it. The resources of the state should be drawn upon, and the facilities of the Experiment Stations and Agricultural Colleges utilized to the fullest extent. In order to state the position of the National Government with respect to this work, and to give some idea of the part of the work which it is best fitted to assume, the following paragraph from a recent paper by Hon. W. M. Hays,*) Assistant Secretary of Agriculture, is here inserted.

*) American Breeders' Association vol. 1, pp. 197-200

"The National Department of Agriculture can appropriately take a leading place in making the necessary theoretical investigations of the general facts and the theory of heredity and the breeding of plants and animals. It can also aid the research stations, and the cooperative associations, also firms and private individuals in their work of variety and breed improvement and breed formation. In fact, it can properly become more and more a great clearing house in which cooperation of groups} of the various agencies named can operate. By putting Federal money behind plans of cooperation devised by workers in this central deprrtment, and by other persons, it can greatly aid in inaugurating cooperative enterprises which in the aggregate will be both

> extensive and most efficient. It can be a center of information of means, of general helpful administration, and of actual productive work. The field is so broad that all available agencies should be built up, supported and made prominent each in its own field."

There has now been pointed out the opportunity for improving our domestic hops by curing at lower temperatures, by a study of the nature and conditions of resin formation, by the breeding of disease-resistant races, by selection of the best and most productive types and by the breeding of pure and pedigreed races. The ground has been gone over already in a preliminary way, plans are formulated and the foundations are laid for work along these lines. Its development in the future will depend upon the funds provided for it, and upon the cooperation and support offered by those whom this work is designed to benefit.

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B. T. GALLOWAY, Chief of Bureau.

THE NECESSITY FOR NEW STANDARDS OF HOP VALUATION.

BY

W. W. STOCKBERGER,
PHARMACOGNOSIST, DRUG-PLANT INVESTIGATIONS.

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Chief of Bureau, BEVERLY T. GALLOWAY.
Assistant Chief of Bureau, ALBERT F. WOODS.
Editor, J. E. ROCKWELL.
Chief Clerk, JAMES E. JONES.

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THE NECESSITY FOR NEW STANDARDS OF HOP VALUATION.[a]

INTRODUCTION.

Notwithstanding the fact that the desirability of a definite standard for judging the quality of hops has long been recognized, certain practical considerations have thus far prevented its realization. Not the least among these has been the existence of a wide difference of opinion as to what constitutes quality and as to the nature and desirable amount of the various constituents of a strictly high-grade hop. Partly because of the prevailing uncertainty as regards the basis of quality and in part because of the advantage which a long-established product in one location usually has over the same product from a new region, many consumers practically lay aside all other considerations and buy on the basis of geographical origin.

A careful examination of representative crops of hops in the various hop-growing regions can but lead to the conclusion that a judgment as to quality based on origin alone must in many cases result in a disadvantage to the consumer and in many others operate to the disadvantage of the producer. The difference in the quality of hops produced on farms situated only a few miles apart may be far greater than that between certain selected grades from two or more regions widely separated. There is strong ground for the opinion that this

[a] In connection with investigations on American hop growing and handling, it has become apparent that there is a great lack of uniformity in methods used by American hop buyers in reaching a basis of valuation of the product. Some buyers adopt geographical origin as the important criterion; others the aromatic qualities; others the appearance chiefly; while still others accept various combinations of these qualities. Hence for this important agricultural product there is no generally recognized basis for determining real merit. This is due to a variety of conditions which can not be discussed here. The desirability of reaching some common ground of action is recognized by many not only in America, but also in Europe. The accompanying paper written by Dr. W. W. Stockberger, Pharmacognosist, under the direction of Dr. Rodney H. True, Physiologist in Charge of Drug-Plant Investigations, is presented in the hope that it may aid in bringing order into this phase of the hop situation.—B. T. Galloway, *Chief of Bureau.*

fact is well known to the hop trade, since the reported sales of hops from certain districts bearing a favorable reputation may be several times greater than the production therein. Hops which would be rated of poor quality if their origin were known may obtain very favorable consideration when represented as coming from a locality which has a reputation for hops of fine quality.

Through long experience a considerable degree of skill may be acquired in the discernment of the probable origin of a sample of hops. Some even claim the ability to tell from an inspection of the sample the exact section or river valley in which the hops were produced. This they may succeed in doing at times in the case of the poorer grades or when there is present a secondary factor due to some peculiarity in the method of curing or in the manner of preparation, but they can not generally succeed, as such judgment, based merely on the marks of superficial resemblance, can at the most be only guesswork. The extravagance of these claims was amply demonstrated in a case that came under the personal observation of the writer. A man who has had a wide experience in the hop industry extending over many years made up in a uniform manner a series of samples of hops from the principal hop-growing sections of the United States. The samples were all of fair quality and in their selection marked physical deficiencies were purposely avoided. These samples were then marked with a cipher and submitted in turn to a number of expert judges of hops. Not one was able to identify the samples correctly. Moreover, the man who prepared these samples could not place them correctly without the cipher. This and other similar experiences indicate clearly that too much emphasis is laid on geographical origin as a criterion of quality in hops.

PRESENT METHODS OF VALUATION.

Almost without exception the producer sells hops on the basis of an empirical physical examination, but the consumer who purchases his supply from a dealer or broker may subject his samples to chemical as well as to physical examination. The points which are considered in estimating quality are numerous and vary considerably according to individual ideas. The more important of these are: Aroma or flavor, color, amount of lupulin, "richness" or "fatness," curing, picking condition, freedom from leaves and stems, etc., freedom from mold and insects, amount of broken hops, quantity of seeds present, maturity, softness of texture, silkiness, stickiness or oiliness, flakiness, size of the cones, degree of sulphuring, and "feel."

Certain features, as, for example, the presence of leaves and stems, mold, insects, lack of lupulin, broken hops, and musty or sour smell, are generally considered as detrimental to quality and are usually to

be readily determined by inspection. The relation which such characteristics as aroma, color, size of cones, etc., bear to quality depends entirely on individual preference and is not determined by any particular standard. The judgment is formed from the impressions made by the hop upon the senses of sight, smell, and touch, and hence gives no quantitative measure of the characteristics of the hop.

In Germany a nearer approach has been made to a uniform method by the adoption of schedules or score cards which attach relative values to certain characteristics. The following is the schedule by which hops were rated at the sixth exhibition of the brewing barley and hops of Baden, held at Augustenberg in October, 1907:

Development of the cones.	Quality and quantity of lupulin.	Aroma.	Color.	Picking.	Drying.	Sorting.	Total number of points.[a]
Number of points considered in rating.							Total number of points.[a]
5.	5.	5.	3.	3.	3.	3.	

[a] Total points possible, 27.

Many other similar schemes have been proposed, but in the end they all depend upon individual taste or preference.

Far less importance is apparently attached to chemical analysis as a means of determining quality. When this method is employed it is customary to determine only such constituents as are regarded of greatest importance. Some consider the hard and soft resins of greatest importance in the measure of quality and hold that in a good sample the soft resins should be not less than three times greater in quantity than the hard resins; some place more weight upon the tannin content; others regard the proportions in which such mineral constituents as potassium, lime, and magnesium occur in the ash as an index to the quality of the hop. It thus appears that the chemical estimate of quality is in as great a state of uncertainty as the physical examination, owing to the lack of agreement as to the relative importance of the constituents determined by this method.

DEFICIENCIES OF EXISTING METHODS.

The greatest defect in the method of physical examination lies in the fact that it is incapable of exact application. The relative value attached to the various points taken into consideration will differ materially with various individuals. Although so much importance is attached to the aroma that with many persons it is the ultimate

test of quality, yet it can give no very accurate information as to intrinsic value.

It has been definitely proved that in many cases certain subconscious factors influence the estimation of aroma and the other constituents of the hop. The chief of these is geographical origin, to which reference has been made. Another is the presence or absence of some familiar physical character which may bear no relation to intrinsic value, but nevertheless affects the judgment. This conclusion was forced upon the writer by the following experiment made several years ago when in the hop fields of California. In this experiment a large basket was filled with hops from the drying floor of a kiln newly filled with fresh hops from the field before either heat or sulphur had been applied. These hops were spread out on the floor of a room, where, protected from the sun, they were allowed to dry. After the hops on the kiln floor had been dried in the usual manner by the application of heat and sulphur fumes the basket was again filled from the kiln floor, this time with dried hops selected from the same part of the kiln that had furnished the first sample. These two samples were, therefore, practically identical in every respect except in the method of drying. The quantity of resins was determined in a portion of each sample and the hops which had been dried on the kiln were found to contain less soft resin than those which had dried naturally on the floor of the room. Small hand samples of each lot were also prepared and submitted to four expert judges of hops who were ignorant of their origin and method of preparation. Two of these judges pronounced the kiln-dried sample superior to the one dried on the floor; two considered the floor-dried sample superior to the one dried on the kiln.

The experience just related affords a splendid illustration of the workings of the present method of valuation and of the great part played by preconceived ideas of merit. It is also of much interest to study the opinions held with regard to German or Bohemian hops, which have long enjoyed the reputation of great superiority over those produced in the United States because of the specially fine aroma ascribed to them. It is apparent, however, that the relationship of the aroma to the other constituents has never been fully determined, but differences in aroma have been assumed to be qualitative and indicative of wide differences in composition. There is evidence for believing that differences in aroma are largely quantitative and that this factor is not necessarily a criterion of quality in the hop. The chaotic condition of existing ideas with respect to hop aroma and quality and the necessity for their thorough revision is further illustrated by the following opinions, each from a different specialist in the use or judgment of hops.

Saaz hops are best.

The idea of the superiority of the foreign hop is largely a matter of prejudice.

German hops are unquestionably best.

Kent hops are the finest; they are better than the German.

The Wisconsin hops are as good as the German.

German hops are best because of their fine aroma. A pound of German hops is worth 3 pounds of American.

The best New York hops are practically as good as the German.

A shrewd dealer can sell anything that looks like a hop.

Since hops of different geographical origin have different flavors, naturally individual preferences become established.

The present method of judging hops is a very doubtful one; prejudice or taste plays the larger part.

Pacific coast hops are stronger in preservative resin than English hops.

American hops can never equal the German, but they can be greatly improved.

So far as general quality is concerned, if New York hops were as carefully picked and handled as the foreign hops they would equal the German in quality.

Differences between American, English, and German hops are almost entirely a question of flavor.

German hops have much more lupulin than the American.

There is a wide difference in the quality of German hops. New York hops grown from German roots are better than the poorer grades of German hops.

Quality really does not amount to much. Salesmanship rather than quality counts. Hops are frequently bought as one kind and sold as another.

Pacific coast hops contain more lupulin than foreign hops.

English hops are superior to the German hops. The superior flavor ascribed to the German hop is chiefly a question of preference.

German hops have a superior flavor but are not so superior to the American hops as has been generally supposed.

The best Pacific coast hops are as good as the German or Bohemian hops.

The uncertainty of the results of physical examination and the difficulty of determining quality in hops by inspection has been long recognized in Germany, where many safeguards have been adopted to secure authenticity in the representation of the origin of their hops. That the hop trade recognizes and plays upon these prejudices is shown by the following statements of Emanuel Gross:[a]

> It is justly alleged against certain dealers that they falsify the origin of their hops. * * * A prominent part is now played by the numerous associations for securing a proper guaranty of the origin of hop parcels. Certain unscrupulous dealers have made fortunes by falsifications of this nature, viz, buying small quantities of, say, fine Saaz hops, mixing them with larger amounts of hops from other districts * * * and selling the whole as Saaz-hops.

The regulations existing in Germany and Austria under which packages of hops are sealed and accompanied by a certificate in order that their origin may be guaranteed in the interests of both growers and consumers, and the requirement in England that hops must be branded with the name and address of the grower, appear to indicate a widespread inability on the part of consumers to judge the quality of hops.

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[a] Gross, E. Hops, pp. 315, 320. 1900.

NECESSITY FOR NEW STANDARDS.

Any rational plan for the improvement of a crop requires a definite standard of quality or value by which deficiencies can be measured and from which clear ideas respecting the lines along which improvement is desirable can be readily obtained. The lack of high standards has too often led to specialization on the feature of yield alone, and the consequent neglect of other factors has tended to reduce rather than to improve the quality. Instead of choosing varieties which produce hops of fine quality, growers have selected those which give the highest yield, believing that the lower price received for the poorer quality was more than compensated by the increased yield received over the better varieties. There is no doubt that the unreliable and inefficient methods of judging quality largely in vogue to-day furnish at least a partial justification for this assumption.

The disastrous prices which have prevailed for several years and the apparent gradual decline in the world's consumption of hops should clearly impress upon hop growers the desirability of better methods of culture and necessity for high and definite standards of quality. When, as is the case at present, the world's production exceeds its consumption, consumers will be hard to please and they can demand and secure the better grades of hops. For the poorer grades no market can be found that will return a profit to the producer.

For a number of years the American hop crop exceeded home demands, and under these conditions the usual practice has been to seek an outlet for the American surplus abroad. In the foreign markets American hops have come into competition with the hops produced in other countries and are judged by the standards of quality which prevail there. The success, therefore, which American hops attain abroad will be conditioned by the degree to which they meet the foreign standards of requirement. Whether these standards are right or wrong, the fact remains that they are firmly established and therefore warrant the careful consideration of the American grower.

Owing to increased production in Germany and Austria there have been heavy exports from these countries to the United States during the past four years. The resulting competition has been unfavorable to American hops because of the reputation for better quality which the imported hops enjoy. To many persons the characteristics of the imported hop form a standard with which all other hops are compared. This is an arbitrary assumption, which fails to consider that there are wide differences in the quality of imported hops, and which determines quality largely on the basis of geographical origin, without reference to intrinsic merit. When the various local and seasonal factors which influence quality are taken into account, it will be seen that present methods are inadequate for the determination of the variation in the hop constituents.

It seems, however, that a careful and unbiased comparative study of the nature and quantitative relations of the constituents of American and European hops has never been made with the view of securing a definite basis for a standard of valuation. A great deal of work has been done on the constituents of hops, but so far no basis of agreement has been reached in the interpretation of the relation of these constituents to quality except in a very general way.

The hops produced in certain regions have established a high reputation and the belief is not infrequently expressed that hops of fine quality can not be grown elsewhere. This is a very broad assertion and is contrary to the results secured with many other cultivated plants. A fact not usually considered is that hops from the same geographical region may differ greatly in aroma. This difference is due to a number of factors, prominent among which are, first, the variety cultivated. Certain varieties possess a well-defined and characteristic aroma, and the possibilities of variation in this characteristic through the crossing of varieties appear to be very great. Second, the aroma is influenced by the time of picking. The volatile oil to which the aroma is largely due increases in quantity as the hop approaches maturity, and as a result fully ripe hops have a stronger aroma than those picked in an immature condition. Third, the process of drying and the "casing" in the cooling room are both capable of inducing modifications in the aroma. These considerations should lessen the dependence placed on origin as a means of determining quality.

Such wide differences in notions of quality as those previously cited could not exist if there were a definite standard by which quality was measured. Not only do the judgments of those who depend upon physical tests alone differ widely, but there is a wide divergence in opinion based on chemical tests as well. Moreover, it is well known that the opinions of those who depend entirely upon physical examination do not often agree with the opinions of those who form their judgments as a result of chemical analysis.

It is essential that there be established uniform methods of making physical and chemical examinations of hops just as there have been established and accepted uniform methods of examining and testing many other materials. Standards of quality must be established also, for a fair comparative valuation can be secured only on the basis of well-defined and universally adopted tests. New standards founded upon an exact knowledge of the nature and relative worth of the various hop constituents are necessary to prevent unmerited discriminations being made in the markets which work a hardship to many American hop growers and which impose unnecessary costs upon the consumer.

MOVEMENT FOR AN INTERNATIONAL STANDARD.

The great inconvenience to the hop trade arising from the lack of a reliable crop-reporting service and from the difficulty of obtaining authentic statistics on the acreage and annual production is appreciated as fully in Europe as in America. As a result of these conditions a movement was set on foot recently in Germany having for its object the formation of an international agreement between the hop-raising States of various countries, under the terms of which a reliable reporting and statistical service might be secured. Pursuant to this end, at the International Hops and Barley Exhibition held at Berlin in October, 1908, a conference was called of all the representatives of hop growers in attendance for the purpose of general discussion, and to consider the establishment of an international bureau of information regarding the production, consumption, and value of hops, and to formulate plans of united action for the mutual benefit of those engaged in the hop industry.

A committee was appointed to work out the details of the plans suggested at this conference and to send them to the hop growers' organizations in the various countries. It was also resolved to call a general conference of representatives of the growers of all the hop-producing countries to meet in Bohemia in the latter part of August, 1909. It was further decided that at this conference the establishment of an international standard for judging the quality of hops should also be carefully considered.

Sufficient reasons have been advanced to show that the adoption of a new and impartial standard of quality is not only desirable but necessary. When it is considered that the favorable reception of American hops abroad depends upon foreign approval; that the adoption of an international standard based entirely upon European ideas of quality without regard to the intrinsic merits of American hops would operate to the disadvantage of the American grower; and that American hops are measured as to quality in their home markets by a standard of excellence based upon the features of hops imported from the German Empire, it seems that the hop growers of the United States should not fail to avail themselves of the opportunity to send to this conference duly authorized and qualified representatives, who should aim to secure more favorable consideration of the qualities of American hops. Every effort should be made to bring about the thorough revision of the methods of hop valuation and to secure the reinvestigation of hop constituents as a step preliminary to the fixing of an international standard, which should be based on intrinsic value without reference to other factors.

The objection may be urged that the American representatives would be so outnumbered in a conference to be held abroad that their

views would not receive full consideration, and that it were better, therefore, to take no part in the movement. On the other hand, no international standard could be adopted except with the accord of all the representatives, and a strong presentation of the necessity for a broader and more thorough basis of hop valuation could not be ignored. Such action should lead to the clarification of ideas respecting the quality of hops.

Approved:

JAMES WILSON,

Secretary of Agriculture.

WASHINGTON, D. C., *May 13, 1909.*

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UNITED STATES DEPARTMENT OF AGRICULTURE

BULLETIN No. 568

Joint Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief, and the Bureau of
Chemistry, CARL L. ALSBERG, Chief

Washington, D. C. PROFESSIONAL PAPER August 8, 1917

THE PRESENCE OF ARSENIC IN HOPS.

By W. W. Stockberger, *Physiologist in Charge of Drug-Plant and Poisonous-Plant Investigations, Bureau of Plant Industry*, and W. D. Collins, *Food-Investigation Chemist, Bureau of Chemistry.*

CONTENTS.

SITUATION WITH RESPECT TO ARSENIC IN HOPS.

At times the detection of minute traces of arsenic in shipments of American hops exported to foreign countries has led to their rejection by prospective purchasers. The loss sustained in such cases is borne by the exporter; consequently American growers, who sell as a rule to local buyers only, do not realize fully the extent to which the salability of American hops on foreign markets may be affected unfavorably by an occasional contaminated shipment.

The profitableness of hop production in the United States is determined practically by the extent of the foreign demand for the crop surplus in excess of the requirements for domestic consumption. Any impairment of the quality of American hops, whether definitely proved or only suspected by foreign consumers, lessens the chances for marketing the surplus at reasonable prices and eventually reacts upon the grower in a lower price for his product. Although the probability of any damage to the public health from arsenic communicated by hops to ale or beer seems very remote, nevertheless the minute quantity of arsenic permissible in hops under some foreign standards of purity lays the grower under obligation to use every reasonable precaution to avoid all possible sources of contamination.

In a bulletin published in 1908 by the Bureau of Plant Industry,[1] impure sulphur was suggested as the source of the traces of arsenic

[1] Stockberger, W. W. The sources of arsenic in certain samples of dried hops. *In* U. S. Dept. Agr., Bur. Plant Indus. Bul. 121, p. 41-46. 1908.

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occasionally found in American hops, and hop growers and handlers were urged to avoid the use of sulphur which could contaminate the hops in the process of drying and curing. Following this publication some hop growers made an effort to secure arsenic-free sulphur, but most of the growers on the Pacific coast continued to use impure sulphur, with the result that each year hops contaminated with arsenic have found their way into foreign markets. In the hops produced in the crop year 1914 the quantity of arsenic present was in many cases so much larger than usual that some English consumers brought the matter informally to the attention of the Bureau of Plant Industry and expressed the hope that American hop growers could be made to realize the seriousness of the situation from the standpoint of the foreign purchaser.

From an inquiry made among the hop growers of the Pacific coast it appeared that the sulphur in common use for bleaching hops was generally regarded either as free from arsenic or as containing this element in quantities so small that no injury would result from its use. The soil, commercial fertilizers, and materials used in spraying, rather than the sulphur, were all suggested as probable sources of the arsenic in hops, but on account of the prevailing uncertainty as to its real source little progress apparently was made in the production of hops of a quality more acceptable to the foreign trade. The reliability of the methods used for the determination of small quantities of arsenic in hops and similar materials was questioned by some who had given careful consideration to the subject. Therefore, the Bureau of Plant Industry and the Bureau of Chemistry undertook a joint investigation in order to establish definitely the source of the contamination of the hops. The field investigation and the collection of samples were made by the representative of the Bureau of Plant Industry, while the study of methods of analysis and the analyses of the samples collected were made in the Bureau of Chemistry.

COLLECTION OF MATERIALS FOR EXAMINATION.

The hop-producing sections of Oregon were visited during the hop harvest of 1915, and a carefully selected series of samples of both hops and sulphur was obtained. Definite information was in hand regarding the origin of certain bales of hops of the crop of 1914 which had been rejected by English purchasers, and it was therefore possible to locate the particular fields on which the hops in many of these bales were produced. It was possible also in some cases to locate and examine the kilns in which some of the rejected hops were dried and to secure samples of the sulphur used in their preparation.

Composite samples of hops from several fields were secured by taking a few hops from each of a number of vines in a field. These

samples were collected just before the crop was picked and were dried carefully in the open air, thus avoiding any possible chance of contamination from the sulphur. For comparison with the field samples thus prepared, samples of the hops from these fields, as well as samples of the sulphur used to bleach them, were taken at the kilns. Samples of kiln-dried hops and, when possible, samples of the sulphur used in bleaching them, were also secured from several widely separated localities. The soils on which these hops were produced varied from the alluvial sandy loam along the river to the clay loam of the uplands and represented practically all the soil types ordinarily used for the production of hops.

Some samples of Fuggle, an early variety, also were collected for comparison as to arsenic content with the later variety known as Cluster or English Cluster.

ANALYSIS OF MATERIALS.

Arsenic was determined by the modified Gutzeit method, following in general the procedure outlined by C. R. Smith.[1] A discussion of the method and of the reasons for adopting the exact details followed in this work will be published elsewhere.[2] The hops were treated with nitric and sulphuric acids to destroy organic matter. The sulphur was treated with bromin[3] and the arsenic separated from the sulphur bromid by extraction with bromin water. In all cases arsenic was precipitated as ammonium magnesium arsenate by adding microcosmic salt, magnesia mixture, and ammonia. The precipitate of phosphate and arsenate was dissolved in sulphuric or hydrochloric acid, the arsenic reduced by stannous chlorid, and arsin generated by the use of zinc. The arsin was allowed to pass over a strip of paper containing mercuric bromid, making a brown stain, the length of which depended upon the quantity of arsenic in the sample. When large quantities of arsenic were present the arsin was passed into a solution of mercuric chlorid; the precipitated mercurous chlorid was filtered on ignited asbestos in a Gooch crucible, dried, and weighed.

RESULTS OF ANALYSES.

The results of the analyses of the field samples, dried in the sun without contact with sulphur fumes, are given in Table I. Although these samples came from widely separated yards and represented two varieties of hops, little difference is shown in their arsenic content, which is uniformly small. The analysis of samples 176, 201, and 202,

[1] Smith, C. R. The determination of arsenic. U. S. Dept. Agr., Bur. Chem. Cir. 102, 12 p., 2 fig. 1912.

[2] Collins, W. D. C. R. Smith's method for the determination of arsenic (with special reference to the determination of arsenic in hops and in sulphur). Presented at the meeting of the Assoc. Off. Agr. Chem., Nov. 20-22, 1916. (To be published in Jour. Assoc. Off. Agr. Chem.)

[3] Smith, W. Estimation of selenium in sulfur. *In* Jour. Indus. and Engin. Chem., v. 7, no. 10, p. 849–850. 1915.

which were of the Fuggle variety, do not differ essentially from those of the remaining samples, which were of the English Cluster variety.

Samples 178 and 186, taken from yards which were not sprayed, showed practically the same quantity of arsenic as the samples from yards sprayed with a solution of whale-oil soap and quassia.

The quantities of arsenic found in the unsulphured samples were far below the limit of 0.01 grain per pound (1.4 parts per million) set in England by the Royal Commission on Arsenical Poisoning.

TABLE I.—*Arsenic in sun-dried unsulphured hops grown at Independence, Oreg., in 1915.*

No.	Source of sample.	Arsenic as As_2O_3 (part per million).	No.	Source of sample.	Arsenic as As_2O_3 (part per million).
176	Yard A	0.2	196	Yard G	0.2
177	do	.2	199	Yard H	.2
178	Yard B	.2	201	Yard I	.1
185	Yard C	.1	202	do	.1
186	Yard D	.1			
187	Yard E	.1		Average	.16
194	Yard F	.3			

The quantities of arsenic found in samples of sulphured hops are given in Table II. Where possible, samples of the sulphur used in curing these hops were collected and analyzed. The results of these analyses also are given in Table II.

Of the 26 samples of kiln-dried hops only four, of which two were duplicates, contained less than 1 part of arsenic per million parts of hops. The average results show that whereas unsulphured hops contain no appreciable quantity of arsenic, hops which were treated with fumes from sulphur having about 100 parts of arsenic (As_2O_3) per million contained about 3 or 4 parts of arsenic per million parts of hops.

On account of the irregularity of distribution of arsenic in the sulphur, it is not possible to be sure that any sample of hops was treated with sulphur of exactly the composition of the sample taken to represent the sulphur. The quantity of sulphur used is also variable, ranging from 1 to 4 pounds of sulphur for 25 pounds of dried hops. Notwithstanding all these chances for disagreement, the results in Table II show in general a relation between the quantities of arsenic in the hops and in the sulphur used in curing. The quantities of arsenic in the hops average about 3 or 4 per cent of the quantity in the sulphur used in curing. On this basis sulphur containing 25 or 30 parts of arsenic per million would on the average contaminate hops with about 1 part of arsenic per million parts of hops. If the arsenic is unevenly distributed through the sulphur it is possible that some samples of hops might contain much more arsenic than the quantity which would correspond to the arsenic in the sulphur.

Table II.—*Arsenic in kiln-dried hops and in sulphur used in curing certain lots of hops grown in Oregon in 1915.*

No.	Source of sample.		Arsenic as As_2O_3 (parts per million).		No.	Source of sample.		Arsenic as As_2O_3 (parts per million).	
	Place.	Yard, etc.	In the hops.	In the sulphur.		Place.	Yard, etc.	In the hops.	In the sulphur.
195	Independence	Yard G	0.4	20	208	Brooks	Yard B	0.5	4.4
229	do	Yard G (duplicates)	6.6	20	205	Springfield	Yard A	4.2	......
233	do	Yard G (duplicates)	7.1	......	210	do	Yard B	4.1	......
198	do	Yard H	5.2	116	206	Harrisburg	Yard A	2.6	......
180	do	Yard K	3.8	356	209	do	Yard B	4.5	......
207	do	Yard L	1.0	......	211	do	Yard C	26.0	......
224	do	Yard M	6.1	35	212	Aurora	......	3.4	115
228	do	Yard N (duplicates)	1.3	......	214	Donald	Yard A	2.7	90
232	do	Yard N (duplicates)	1.2	......	216	do	Yard B	3.4	123
230	do	Yard O (duplicates)	1.9	20	218	St. Paul	......	3.8	116
234	do	Yard O (duplicates)	1.9	......	223	Suver	......	3.9	76
231	do	Yard P (duplicates)	.2	......	225	Banks	......	4.2	188
235	do	Yard P (duplicates)	.2	......		Average	......	3.93	......
204	Brooks	Yard A	1.9	......					

Analyses of all the samples of sulphur collected are given in Table III. With a few exceptions these samples were taken from the hop yards and are representative of the sulphur used in curing the crop of 1915. Three samples of sulphur used in curing the crop of 1914 and two commercial samples also are included.

The quantity of sulphur on hand at the hop kilns varied from a few hundred pounds to several tons. As a rule, the individual lots were far from uniform in appearance, and in many cases several different kinds of sulphur seemed to be present. Some pieces were of a bright lemon-yellow color and others of various shades of orange. Some pieces were hard and glasslike; others appeared more crystalline and crumbled readily, while some pieces were porous, resembling pumice in appearance. In most of the lots the sulphur consisted of pieces of different sizes, from lumps 6 or 8 inches across down to a fine powder. This made sampling difficult, but the agreement between the values obtained for samples 181 and 200, which were taken to represent the sulphur in one lot, indicates that the samples were representative of the various lots at the time of sampling.

Table III.—*Arsenic in sulphur used for curing hops grown in Oregon in 1915.*

No.	Source of sample.		Arsenic as As_2O_3 (parts per million).	No.	Source of sample.		Arsenic as As_2O_3 (parts per million).
	Place.	Yard, etc.			Place.	Yard, etc.	
182	Independence	Yard B	64	213	Aurora	......	115
191	do	Yard F (1915)	197	215	Donald	Yard A	90
192	do	Yard F (1914)	170	217	do	Yard B	123
197	do	Yard H	116	219	St. Paul	......	116
179	do	Yard K (1915)	66	220	Brooks	Yard B	4.4
181	do	Yard K (1914) (duplicates)	356	222	Suver	......	76
				226	Banks	......	188
200	do	Yard K (1914) (duplicates)	329	190	Independence	Commercial sample	3.6
221	do	Yard M	35	227	Portland	Dealer's sample	7.1
193	do	Yard O	20		Average	......	116.7
189	do	Yard R	141				

From two samples of sulphur several pieces of different appearance were picked out, ground, and analyzed for arsenic. with the results given in Table IV.

TABLE IV.—*Arsenic in different pieces of sulphur from the same field sample.*

No.	Sub-sample.	Appearance.	Arsenic as As_2O_3 (parts per million).	No.	Sub-sample.	Appearance.	Arsenic as As_2O_3 (parts per million).
179	1	Greenish yellow	10	188	3	Lemon yellow, largely crystalline	160
179	2	Slightly orange, porous	270	188	4	Orange, vitreous	150
179	3	More orange than sub-sample 2	160	188	5	Lemon yellow, crystalline	50
179	4	Average of the sample	66	188	6	Orange, vitreous	450
188	1	Average color	35	188	7	do	300
188	2	do	80				

After a small part of sample 179 had been removed in subsamples 1, 2, and 3, the remainder was ground and used as an average sample of 179 in the same way in which the other samples of sulphur were used. It is believed that the average value of 66 parts per million is not appreciably different from that which would be obtained for the arsenic in sample 179 if no subsamples had been removed. So many subsamples of sample 188 were taken that it was not possible to obtain an average value of this sample.

The results of analyses of the subsamples of sample 179 indicate that with sulphur taken from a lot containing on the average 66 parts of arsenic per million, one kiln of hops might be treated with fumes from sulphur containing 270 parts of arsenic per million, while the next treatment might be with sulphur containing only 10 parts of arsenic per million.

Since only a small quantity of sulphur is burned at one time in curing hops, it is very probable that the sulphur used on a particular kiln of hops will not contain the same quantity of arsenic as an average sample of the sulphur on hand.

The results for the subsamples of sample 188 show irregularity of distribution of arsenic much like that in sample 179. The relation between the arsenic in sulphur and in the hops for which the sulphur is used can not be very definite. No uniform quantity of sulphur is used for a given quantity of hops; the arsenic is not uniformly distributed through the hops in the kiln at one time and the arsenic is not uniformly distributed through the sulphur.

The analyses of samples 190, 220, and 227 show that sulphur can be obtained which is practically free from arsenic. The analyses of samples of hops cured with sulphur containing very little arsenic indicate that hops may be cured with sulphur containing as much as 10 parts of arsenic per million without becoming contaminated with more than 0.5 part of arsenic per million parts of hops.

CONCLUSIONS.

The work here reported shows that sun-dried hops collected from various yards in Oregon in 1915 contained practically no arsenic.

The spraying materials in general use, such as solutions of whale-oil soap and quassia or nicotin sulphate are not to be held responsible for the contamination of hops with arsenic.

The sulphur in use in 1914 and 1915 was generally contaminated with arsenic, many samples containing over 100 parts of arsenic as As_2O_3 in 1,000,000 parts of sulphur. When such sulphur is used in curing hops, the hops may contain three or four parts of arsenic per million parts of hops.

Little, if any, doubt remains that impure sulphur alone is responsible for the contamination of hops with appreciable quantities of arsenic.

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PROGRESS OF HOP CULTURE IN THE UNITED STATES

Dr. W. W. Stockberger, Bureau of Plant Industry, United States Department of Agriculture

The growing of hops is one of the oldest agricultural industries in the United States. The early colonial records show that hops were brought into the New Netherlands in 1629, and into Virginia about 1648. The cultivation of hops in Virginia was for many years not commercially successful since the quality was poor, but in New England the culture became firmly established. For many years the industry progressed slowly and was largely centered in the states of Vermont and Massachusetts, where, as early as 1800, a considerable quantity of hops was produced. The success attained in the New England States led to the introduction of hop culture in New York in 1808, and it was not long until the center of the industry had shifted westward to this State, which for many years held first rank in hop production. By the middle of the century hop culture had spread to the Middle States, and formed a crop of some importance in Ohio, Indiana, Michigan and Wisconsin. In the latter state the industry developed greatly, and in 1869 the production was one-fourth that of the state of New York. But in the years immediately following, a decline in prices and serious attacks of the hop aphis so affected the industry in this state that it entered upon a decline from which it has never recovered.

The cultivation of hops on the Pacific Coast was apparently first introduced in Oregon, where, according to the returns of the United States Census, eight pounds were produced in 1849. Twenty years later the production had barely reached ten thousand pounds, but in 1879 Oregon had attained fifth rank as a hop producing state. In 1856 DANIEL FLINT began the cultivation of hops in California, and ten years later the first commercial planting in Washington was made by JACOB MEEKER near Puyallup.

From the very small and unimportant place occupied by this crop in the first century following its introduction into America, it has steadily risen until it now ranks about fourteenth in value among our agricultural industries. From time to time the center of this industry has shifted westward apparently in obedience to natural economic laws. The rich fertile soils of the West and the freedom at first from pests and disease made possible the production of hops under conditions much more favorable than those existing at the point of introduction of the culture into America. Moreover, as the population increased and the agricultural resources of the country began to be developed, other industries were introduced which if not more remunerative, were at least more certain of yielding a definite annual return for the labor expended, and hence by degrees supplanted the growing of hops in the sections where they were formerly cultivated to a large extent.

Although the economic importance of the hop crop is by no means inconsiderable, nevertheless the acreage devoted to hop production seems very small in proportion to the whole body of agricultural land in the United States. For the past ten years approximately fifty thousand acres have been annually under hops. This is about one-hundredth of one per cent of the improved land now in farms, or one acre of hops to every 9548 acres of farm land. Records are not available showing the number of farmers devoting all or part of their efforts to hop growing, but it seems safe to assume that the number of persons in the United States who may be rightfully designated as hop growers includes several thousands. The number of persons who are directly affected by the returns derived from this crop is much greater, since the labor of many hands is necessary not only during the cultivating season, but particularly at the time of harvesting the crop. During the past ten years the United States has produced an average of forty-six million pounds annually. The price paid for picking alone is approximately three cents per dry pound. On this basis the sum of one million, two

hundred and eighty thousand dollars would be disbursed annually among the thousands of unskilled laborers, comprising not only men, but also women and children, who find several weeks' employment during the season of the hop harvest. It is therefore evident that this industry is not only an important one from the standpoint of the farmer alone, but that it is also an item of consideration with thousands of persons who for their livelihood depend upon some form of common hand labor.

Improvements in Methods of Hop Production.

A full discussion of the many improvements which have been made in the methods of hop production would be timely and very instructive, but the limits of this paper permit only an enumeration of some of the more important ones. One of these is the system of drying. After years of experimentation, during which many systems were tried and discarded as inefficient, two types of kilns have been evolved for which superior advantages are claimed. The one is a stove kiln of wooden construction with a high drying floor which prevents scorching the hops. The kiln is so constructed that the heat is evenly distributed and under thorough control through a system of ventilators, and that the necessary draft is secured at the temperature most suitable for curing. The other type, often built of concrete, is fire proof and is equipped with a blast fan by which air of the required temperature is forced through the hops from below. By this method overheating, overdrying and scorching are avoided.[1]

The introduction of what is known as the high-wire trellis system of training hops marks another distinct improvement. The principle of this trellis is much the same as that of the post and wire trellis now in occasional use in Saaz, Auscha, Hallertau and Spalt, but it differs in some essentials of construction. Except in wind-swept regions its advantages over the pole system are very great. On this trellis the hops develop more uniformly, are more successfully sprayed, mature earlier, are usually richer and brighter, are less leafy and the vines can be more readily handled at picking time. The great superiority of this trellis will certainly lead to its being universally adopted.

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1. For a full description of these two types of kilns see Farmers' Bulletin No. 304, U. S. Department of Agriculture, entitled, "Growing and Curing Hops," by Dr. W. W. Stockberger.

The improvements of devices for spraying have been noteworthy. In the early form of apparatus the air pressure necessary to discharge the spray was developed by hand power. This was followed by a sprayer, propelled by horse power, in which the pump is operated through a system of gears connected with the wheels of the apparatus. The great fault of this device lies in the necessity of its being kept in almost constant motion if the requisite air pressure is to be maintained. This difficulty was overcome in a new type of spraying rig in which a small gasoline engine furnishes the motive power for the pump. In the latest modification of spraying apparatus both engine and pump are discarded and the necessary pressure is secured by means of compressed air. In some cases the spray tanks are directly charged with air under heavy pressure, in others steel tubes or "bottles" are charged with air under a pressure of 700-800 pounds and from these the air is admitted to the spray tank at a rate sufficient to maintain the necessary pressure. The "bottles" are charged at a central air-compressing plant and are distributed about the field to the various spraying outfits as required.

Great improvements have been made also in the presses for baling hops. Although presses operated by hand power are still widely used by small growers, they have been discarded entirely by the large growers for presses operated by horse power. Two of these, the Sacramento press used chiefly in California, and the Salem press widely used in Oregon and Washington, are very efficient. These presses have not only diminished the amount of hand labor required but they have also cheapened the cost of baling and at the same time increased the daily output of bales by a given force of laborers.

The possibility of picking hops by machinery has long engaged the attention of hop growers. In the United States many machines have been invented for this purpose but absolute unfitness for the work they were intended to do has characterized practically all but one. Between the years 1868 nd 1896 Letters Patent were granted to the inventors of no fewer than 28 hop picking machines, not one of which was successful. However, within the last few years a machine has been invented by Mr. E. C. Horst, of San Francisco, which, in spite of its defects does pick hops. The correct principle of a hop picking machine seems at last to be uncovered, and if the mechanical difficulties that now impair its efficiency can be overcome, a machine will have been evolved that should revolutionize

the common method of picking hops. Perhaps its greatest service will be to free the hop grower from the uncertainties attendant upon the present necessity for the employment of a large number of unskilled laborers for harvesting the crop.

Progress in Control of Hop Pests and Diseases.

The pests of the hop crop are very numerous, in fact the number of plant and animal forms which depend upon the hop for all or part of their subsistence is surprisingly large. Fortunately very few of these pests are sufficiently formidable as yet to cause much distinct damage to the crop in the United States.

Some preventive or palliative measures, however, are desirable in case of the occurrence of the following:

1. The Hop Aphis (*Phorodon humuli*). This insect, commonly known as the hop louse, has been known in the eastern part of the United States for about one-hundred years. It became destructive in Wisconsin about 1870 and twenty years later reached the Pacific Coast where it entailed great damage to the crop in Oregon and Washington. Later it appeared in California and there is now practically no hop growing section free from its ravages. The life history of the hop aphis is apparently not identical in all sections[2] and in consequence some variation in the application of remedies for its control is necessary. Experience has pretty well established the efficacy of spraying with kerosene emulsion and tobacco or with whale-oil soap and quassia. The consistent and thorough application of these sprays serves very effectually in controlling the hop aphis.

2. The Hop Flea-beetle. (*Psylliodes punctulata*). This pest has caused great damage to the hop industry in British Columbia and threatens to become destructive in Oregon and Washington. Its life history is only partially known and satisfactory methods of control still remain to be developed. Extensive experiments have been made with a large number of remedial agents[3] but owing to the constant reappearance of the beetles and the rapid growth of the young hop vines, most of the remedies have been ineffective. Clean methods of culture are said to be the most promising measure of control.

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2. Riley, C. V., "The Hop Plant-louse and the Remedies to be used against it," Circular No. 2, 2d ser., Division of Entomology, U. S. Dept. Agriculture, 1891.

Clark, W. T., "The Hop Aphis," Bulletin No. 160, Agr. Exper. Station, Univ. of California, 1904.

3. Chittenden, F. H., "The Hop Flea-beetle," Bulletin No. 66, Part VI., Bureau of Entomology, U. S. Dept. Agriculture, 1909.

3. The Hop Mildew. (*Sphacrotheca humuli*). This disease is the well known "mildew" or "mold" of England, where it is very destructive. Its first appearance as a destructive hop pest in the United States occurred in central Vermont about 1863, where it practically destroyed the industry. No other sections were seriously affected by the mildew, and for many years its presence was not observed by hop growers, but in 1909 the crop in certain yards near Waterville, New York, was destroyed by this disease, and each year since it has become more widespread. The outlook for the future of the hop industry in New York is not promising unless concerted action is taken by the growers for the control of this disease. Some experiments have been made with various remedies, and dusting with flowers of sulphur has so far yielded the most satisfactory results.

4. The Hop Crown-gall. (*Bacterium tumefaciens*)[4]. In many of the hop yards on the Pacific Coast gall-like growths can be found on the roots and crown of the plant. Although these growths are not generally recognized as injurious, the observations of many growers confirm the view that this disease may do considerable damage. Some believe that the short life of many of the hop plants is due to the attacks of these galls, and there can be no question that they seriously affect the general health and vigor of the plant. The disease threatens to become widely distributed through the practice of taking cuttings for propagation from affected plants. Since the disease is bacterial in nature practical field treatment for its control becomes a very difficult problem. The most promising remedy seems to lie in the discovery and propagation of plants resistant to the attacks of the organism which produces the gall.

5. The Red Spider (*Tetranychus bimaculatus*). The ravages of this pest are most serious in dry seasons. The lower leaves of the plant are first affected; they gradually become yellow or brown, wither and fall off. Eventually the cones are affected and rapidly become red in color. When the spider appears early in large numbers the damage to the crop is apt to be great. Numerous insecticides have been used with varying degrees of success. Since the spider occurs on the under side of the leaf successful spraying becomes a difficult problem. Dusting with dry sulphur has served very well to control the spider but frequent applications are necessary. Thorough spraying with water alone, if a moderately high

4. Smith, E. F., Nellie A. Brown and C. O. Townsend. "Crowngall of Plants," Bulletin No. 213, Bureau of Plant Industry, U. S. Dept. Agriculture. 1911.

pressure is maintained, will serve to dislodge the spider from the plant, and is recommended especially in cases where there is danger that the application of the usual spraying mixtures will either injure the foliage of the plant or result in the deposition of undesirable materials upon the hop cones.

The Work of the Department of Agriculture for the Improvement of the Hop Industry.

The documents published by the Department of Agriculture show that for many years some attention has been given to certain problems relating to the growing of hops. To date the Department has issued ten separate publications devoted exclusively to hops and many minor reports upon various phases of the industry occur in numerous Reports and Bulletins. Prior to 1905 no systematic study of the general conditions of hop culture had been undertaken and the published reports show that the problems considered were only those concerning which there seemed to be a demand for immediate attention.

In response to the urgent requests of prominent hop growers it was decided in 1905 that the Bureau of Plant Industry should undertake a study of the possibilities of effecting improvements in the quality and yield of American hops, and the work has since gone forward without serious interruptions. During this time the Bureau of Entomology and the Bureau of Statistics have contributed valuable publications in their respective fields of work.

One of the first subjects to receive attention was the prevailing method of drying hops. It was found that some form of stove-kiln was in general use and that during drying the hops were subjected to temperatures often reaching 180° F. Aside from other evils attendant on the use of high temperatures it seemed evident that the soft resins, one of the most important constituents of the hop, would be subjected to deterioration. This was tested practically by selecting uniform samples of hops which were divided into two portions, one being dried on the kiln in the usual manner, the other being allowed to dry naturally in the shade. The soft resins were then determined in each portion and the results are illustrated by the following analyses selected at random:

	Per cent of soft resins	
Lot No.	Kiln dried	Shade dried
303	12.50	15.11
304	12.66	16.02
308	14.71	15.03
309	12.96	14.42

These determinations and others made on samples dried at different temperatures clearly support the view that the amount of soft resins is conditioned by the temperatures at which hops are dried. In a published report[5] embodying the conclusions reached the writer has urged the use of lower temperatures in drying.

The possible source of arsenic sometimes found in hops has also been studied, and the writer has reached the conclusion that it comes from impure sulphur used for bleaching the hops at the time of drying. A series of tests made on a small kiln, in which the hops were heavily sulphured, furnished the supporting evidence. Samples were taken from both the top and the bottom of the layer of hops before they were removed from the kiln after drying. The arsenic in these samples was then detemined with results of which the following analyses are typical:

No. of sample	Pounds of sulfur per 100 lbs. green hops.	Position in kiln from which sample was drawn.	Metallic arsenic in parts per million.	Grains of arsenic per pound of dry hops.
145	6	Top	5.0	0.035
146	6	Bottom	24.0	0.168
153	6	Top	6.0	0.042
154	6	Bottom	17.0	0.119
151	12	Top	6.0	0.042
152	12	Bottom	32.0	0.224
155	12	Top	14.0	0.090
156	12	Bottom	120.0	0.840

By this experiment the source of the arsenic was revealed and the wide variation in arsenic content of samples from the same lot was fully explained. These results were widely circulated among the hop growers and the use of sulphur free from arsenic was strongly recommended.[6]

With the purpose of improving the American hop in mind, Mr. David Fairchild of the Bureau of Plant Industry, imported in 1900 a large number of sets of the best European varieties of hops. After thorough trial it was found that the yield of these varieties was so small that they could not be grown at a profit in America. Profiting by this experience the writer on taking up the work of hop improvement decided to rely on the production of new

5. Stockberger, W. W. "Growing and Curing Hops." Farmers' Bulletin No. 304, U. S. Dept. of Agriculture, 1908, pp. 19-26.

6. Stockberger, W. W. "The Sources of Arsenic in Certain Samples of Dried Hops," Bulletin No. 121, Part IV, Bureau of Plant Industry, U. S. Dept. Agriculture, 1908.

varieties by seedlings from the original stocks and by the selection of the best and most productive types from among the varieties locally cultivated. The work with the seedlings has now reached a very promising stage. About 2000 seedlings have been brought into bearing and from among these a number of types have been isolated which expert judges of hops have found to be of superior merit. Through the propagation and distribution of these new types the attempt will be made to displace the less desirable types and thereby to raise materially the general standard of quality.

The work of general selection is still in progress but has already yielded valuable results. The records of yield for a large number of individual hills are now complete for a period of three years and so far indicate that certain plants consistently produce 50 to 80 per cent more hops each year than other plants in the same field. If it should be found that these tendencies toward high and low yield respectively are inherited by new plants propagated in the usual manner by sets or cuttings it follows that it should be possible to materially increase the average yield by always taking new cuttings from high yielding plants.

A study of the relation of the number of vines trained to each hill to the yield[7] has shown that in some hop growing sections at least the training of more vines to the hill should be followed by a corresponding increase in the yield. Observations were made on 853 hills which varied from one to 7 in the number of vines per hill. The variation in the average yield per vine was 0.28 pound, and for practical purposes may be neglected. On the showing of the data collected, if the number of vines to the hill were increased from 4 to 6 a corresponding increase of 50 per cent in the yield should be expected. The operation of other factors of crop production, however, has been found to diminish the expected per cent of increase but a sufficient margin remains to make the increase in number of vines trained to the hill commercially profitable.

Work is in progress along a number of other lines and many experiments have been made, the results of which have not yet been formulated for publication. Among these, mention may be made of a comparative study of a large number of methods of pruning, the object of which is to determine the one which gives the best results at harvest time and which secures to the plant the greatest freedom from disease and the influence of unfavorable weather

7. Stockberger, W. W. and James Thompson. "Some Conditions Influencing the Yield of Hops," Circular No. 56, Bureau of Plant Industry, U. S. Dept. Agriculture, 1910.

conditions; the study of the adaptability of various varieties; the determination of the cause of certain diseased conditions and malformations of growth; and the effects of climate upon the development and quality of the constituents of the mature hop.

In the laboratories of the Bureau of Plant Industry an extended study of the volatile, aromatic constituents of hops has been made, and oils distilled from hops grown in Bohemia, New York, Washington, Oregon and California during the seasons 1907, 1908 and 1909 have been examined with respect to their physical and chemical constants. The tabulation of the results of the work appears to indicate that the oils from hops grown in the same section are very similar from season to season, while the oils from hops grown in different sections show fairly constant differences. These differences seem to depend very largely on the source of the hops, and the complete results of this work promise to give an analytical method for determining the origin of hops.

For several years the writer has been personally active in advocating the adoption of a new standard for hop valuation[8]—one which should not consider the physical properties of hops alone but which should also regard certain intrinsic qualities which are elements of the brewing value. It is now quite generally conceded both in the United States and in Europe that the amount of soft resins, with which the bitter acids are associated, and also the antiseptic strength of the hop are important factors affecting quality. In fact some international authorities have personally stated to the writer that these are the sole factors affecting quality. The action, therefore, of the progressive Committee on Awards of the Second International Barley and Hop Prize Exhibit, in adopting a standard for hop valuation disregarding geographical origin and recognizing the importance of the content of hop-bitter acids is highly gratifying and marks a most important step toward a solution of the much disputed question as to the relative value of hops, which, in the last analysis, must rest upon the intelligent judgment of the consumer. When such a solution is reached the efforts which the National Department of Agriculture is now making to improve the quality of our American hops will be enormously facilitated.

8. Stockberger, W. W. "The Necessity for New Standards of Hop Valuation," Circular No. 33, Bureau of Plant Industry, U. S. Dept. Agriculture, 1909.

RELATION OF STAND TO YIELD IN HOPS.[1]

By W. W. Stockberger, *Physiologist*, and James Thompson, *Scientific Assistant, Office of Drug-Plant, Poisonous-Plant, Physiological, and Fermentation Investigations.*

INTRODUCTION.

Among many hop growers the impression prevails that the average yield of hops per acre is annually growing less and that the productivity of a large proportion of the hop soils is decreasing. The statistical data on this point, however, are so meager that it seems unwise to draw from this source very definite conclusions regarding the increase or decrease in yield per acre. From the records of the United States Census the average yield per acre of hops can be determined only at 10-year intervals throughout a period of 30 years, and since the figures for any given year will vary widely, depending on whether a light or a heavy crop is produced, it is manifestly unsafe to assume that the averages for the census years necessarily represent actual conditions for the intervening years. If records of the average yield were available for each one of the 30 years the evidence of the figures might be accepted as a fair indication of the general trend of the yield of this crop.

The average yield per acre is materially influenced by a number of factors, prominent among which are seasonal conditions, soil type, and cultural methods. In case large areas are under consideration, such as a county or State, extensive changes in acreage or a shifting of the area of production may also materially affect the average yield. When such modifications take place, changes in the average yield reported for the given area have little bearing on the question of diminishing crop yields. Nevertheless, the statistical data on the average yield per acre in the several hop-growing States and in the chief hop-producing counties therein are worthy of careful consideration by every grower of hops, but it is of far greater importance that he should be fully informed as to the successive yields of his own fields.

On certain types of soil not so well adapted to hops as the richer alluvial soils there is ample evidence of a declining yield, due fundamentally to soil conditions. This decline is most noticeable in hop-yards located on uplands where beneath the shallow surface soil

[1] Issued Feb. 8, 1913.

there is a layer of hardpan and clay. On the other hand, it is far from clear that the diminished output per acre reported for some of the rich, deep alluvial soils is due to their decreased productiveness, especially if such soils are overflowed in winter and thereby receive a deposit of sediment. The fact that the application of commercial fertilizers to some of these soils has as a rule yielded negative results seems to indicate that they are not lacking in available plant food, and a study of the other factors concerned will probably reveal the most important causes of the decline in yield, if such is actually taking place.

It is the purpose of the present publication to direct attention to the often unappreciated extent of the losses due to imperfect stand and to offer certain suggestions which, if followed, should result in an increased yield without materially increasing the cost of production.

CAUSES OF IMPERFECT STANDS.

In newly planted yards a small percentage of missing hills may normally be expected, owing to the failure of some of the cuttings to strike root. In most cases, after a yard has come into full bearing the stand tends to become poorer and poorer through the dying out of the plants from causes at present imperfectly understood. This dying out occurs in all the hop-growing sections of the United States, but it is far more prevalent in some districts than in others. Many ingenious explanations have been offered to account for this trouble, but a satisfactory one yet remains to be found. From extensive observations made in the hop fields of the United States and of Europe the writers have reached the tentative conclusion that a primary cause lies in too severe or faulty pruning, in the bruising of the roots in plowing, and in the crushing of the crown of the plant by the feet of horses and the wheels of wagons when teams are driven over the fields.

Hills often die out because of weakness or disease induced either by the rough treatment received when they are uncovered at pruning time or by the injuries inflicted by the plow or other implements used in cultivation. When the roots are bruised or torn they heal slowly and imperfectly and are almost certain to become infected by some of the destructive organisms widely distributed in the soil.

In most hopyards some attention is given each year to replanting the missing hills, but, since the trouble is rarely taken to make certain that the cuttings are sound and vigorous and that they come from hills selected for their thriftiness and high yield, many replants either die outright the first year or maintain a struggling and unprofitable existence. The vigor of the cuttings is often impaired through the lack of precaution to keep them from drying out before

they are set, or the replanting is deferred until the soil has become so dry that it does not afford the conditions essential to proper growth. Replants usually make a poor growth unless the site of the missing hill which they are intended to replace is excavated, the dead crown and roots removed, and the soil replaced by fresh earth taken from midway between the rows.

The stand may become imperfect through numerous other causes, but the ones here described should receive first consideration, since it is within the power of the hop grower to minimize in great measure their effect.

VARIATION IN THE PERCENTAGE OF PERFECT STAND.

The percentage of perfect stand varies widely and is to a large extent dependent upon the local conditions affecting a given hop field and upon the knowledge, skill, and industry of the hop grower. In some yards which have come under the writers' observation a careful count of the missing hills showed the stand to be 99.3 per cent, while in other yards the stand was found to be as low as 75 per cent. These, of course, represent extreme cases and are far less numerous than those in which the stand ranges from 90 to 95 per cent for individual fields. The percentage of stand for any given yard will be found to fluctuate from year to year, according to the rate at which the hills are dying out and the care and attention given to replanting.

The estimate by inspection of the number of missing hills and the percentage of stand have been found to be very misleading. In every case in which a grower's estimate of the percentage of stand has been verified by an actual count of the missing hills, his estimate has proved too high, and it is believed that growers often deceive themselves as to the extent of the loss suffered through an imperfect stand. An estimate of the percentage of stand that is based on a count of the missing hills in every fifth or tenth row, although less accurate than a full count, is much to be preferred to one based on inspection alone.

VARIATION IN STAND ON A SINGLE ACRE.

An exact record of the stand on an acre for 4 consecutive years shows some striking variations which are believed to be fairly representative of the conditions existing in many hopyards. This acre was laid off at one side of a large field which had been under hops continuously for 10 years, and during the 4 years it was under observation it received the same attention and culture treatment as the remainder of the field of which it forms a part. At harvest time each year a record was made of the condition of each hill, and the position of each hill that was missing or which had vines bearing no hops was noted on a chart. From this chart the data in Table I were compiled.

TABLE I.—*Comparison of the stand of hop plants on 1 acre for the years 1909 to 1912, inclusive.*

Factors of variation.	1909	1910	1911	1912
Productive hills	853	865	887	790
Missing hills	56	66	24	113
Hills having vines with no hops	43	21	50	58
Hills having "bastard" vines	5	10		
Hills having male vines	10	5	6	6
Total	967	967	967	967
Stand per cent	94.2	93.1	97.5	88.3
Productive stand do	89.1	89.9	92.2	82.2

With a perfect stand, under the system of planting followed on this acre, there would be living plants in each of the 967 hills. Owing to the prevalence of missing hills, however, the stand has been more or less imperfect each year, as shown by the percentages given in Table I. Aside from the missing hills the crop is further influenced by the constant occurrence of unproductive plants. Of these, there are three classes: The male plants, of which a small number is considered essential by American hop growers; the "bastard," or mongrel, plants, the frequent occurrence of which is restricted to certain localities; and the normal female plants which from one of several causes are nonproductive. When yield is considered, the nonproductive as well as the missing hills must be taken into account, since the yield per acre is directly proportional to the number of productive hills. The percentage of productive stand, by which is meant the percentage of bearing hills, is an important index of productiveness, and on the acre in question this figure shows, as may be seen from Table I, that each year about one-tenth of the hills are wholly unproductive.

The records of the individual hills show some of the important reasons for the variation from year to year in the number of missing hills. The two chief causes of this variation are the more or less successful yearly replanting and the annual occurrence of new missing hills. The variation in these factors is numerically expressed in Table II.

TABLE II.—*Annual variation in the number of replanted and missing hills of hops on 1 acre.*

Factors of variation.	1909	1910	1911	1912
Hills successfully replanted	No record.	12	57	21
Hills previously missing and not successfully replanted	...do......	44	9	3
New missing hills	...do......	22	15	110
Total number of hills missing	56	66	24	113

The importance of replanting and the success with which it has been carried out on the acre under observation may readily be judged from Table II. In 1910 less attention was bestowed upon the replanting than in the two succeeding years, with very obvious results. Were it not for the continuous dying out of the hills an almost perfect stand could readily be attained. It is important to note that each year there was added to the list of missing hills a number that previously had been productive. In fact, it frequently occurs that a hill which has been producing heavily for several years suddenly becomes "missing." Of the 110 new missing hills recorded in 1912 the average yield for the previous year was 10.2 pounds green weight, and 56 of these hills had each given a high yield in the years 1909 to 1911, inclusive.

Out of the entire number of hills on this acre only 1 has been missing for the whole period of four years, 4 have been missing for three consecutive years, and 45 for two years in succession. Of the 56 hills missing in 1909 only 6 were still missing in 1912. Altogether, 193 different hills have been missing on this acre during the past four years, which would have necessitated the replanting of more than 20 per cent of the entire number of hills if a perfect stand were to be maintained. The fact that new missing hills occur each year, many of which have previously been highly productive for several years, strongly suggests that the average length of life of the cultivated hop plant may be less than is popularly supposed. Cases are known where it is claimed that individual plants have given a fair yield each year for 30 years, but many growers agree that, with a newly planted yard, after three or four crops have been harvested the hills begin to die out to a greater or less extent. Positive conclusions on this point, however, can not be drawn from the data in hand, since the period covered by the observations is entirely too short to be more than suggestive.

VARIATION IN PRODUCTIVE STAND.

A large part of the variation in productive stand is caused by the occurrence of hills having vines producing no hops. Such hills present a greater problem than those which are missing, since many of them if left undisturbed produce a good crop the following year and digging them out and setting new plants might result in loss rather than gain. Each year a few of the replants fail to bear hops; others of the hills are probably unproductive through loss of vigor, since a number are dead the following year, and some vigorous and normally productive hills through some accident fail to yield a crop. How these various classes among the hills having vines but no hops are distributed from year to year is shown in Table III.

TABLE III.—*Record of the hills on 1 acre having vines but producing no hops, for the years 1909 to 1912, inclusive.*

Year.	Total hills.	Re-planted hills.	Productive hills.		Nonproductive hills.		Hills dead the following year.
			Previous year.	Following year.	Previous year.	Following year.	
1909	43	(1)	(1)	36	(1)	1	6
1910	21	2	17	18	2	1	2
1911	[2] 50	19	25	37	6	5	8
1912	58	3	51	(1)	4	(1)	(1)

[1] No record.
[2] The crop on 24 of these hills was lost through defective supports, which allowed the vines to fall to the ground.

This table shows that the relation existing between the newly replanted hills and those having vines but no hops is less close than is generally supposed, since the number of the latter which were replants is small both in comparison with the total number of hills having vines producing no hops and with the number of hills successfully replanted, as shown in Table II. The figures in columns 4 and 5 of Table III indicate that of the hills having vines but no hops in any given year the greater number were productive in the previous year as well as in the one immediately following. Similarly, the figures in columns 6 and 7 show that very few of these hills were nonproductive in either the previous or the following year. Finally, from the last column it appears that relatively few of the hills having vines but producing no hops are numbered with the dead the following year.

In view of the facts here presented there seems no escape from the conclusion that a large number of the cases of hills having vines but no hops arise through neglect or carelessness in cultivating or caring for the plants up to harvest time.

LOSS IN YIELD DUE TO DEFECTIVE STAND.

Everyone recognizes that, as a rule, a poor stand means a diminished yield, but it frequently happens that the extent of this loss is not fully appreciated. This is particularly true when the number of missing or nonproductive hills is small, for then the grower often feels that the saving would not be large enough to warrant his giving the time and attention necessary to maintain a full productive stand. This impression is likely to persist unless some relative numerical expression is found that will approximately represent the extent of the loss. A fairly satisfactory method of estimating loss is to determine the percentage of productive stand and the actual yield, say on 1 acre, and from these figures to calculate what the yield would be on the basis of a productive stand of 100 per cent. The difference between the estimated yield and the actual yield will then represent

the loss. Applying this method to the records of the acre discussed in the previous paragraphs the results set forth in Table IV were obtained.

TABLE IV.—*Estimated loss and comparison of actual with estimated yield on 1 acre of hops.*

Year.	Productive stand.	Actual yield, dry weight.	Estimated yield with full productive stand.	Estimated loss due to lack of stand.[1]	
				Quantity.	Value.
	Per cent.	*Pounds.*	*Pounds.*	*Pounds.*	
1909	89.1	1,487	1,668	181	$29.32
1910	89.9	1,443	1,605	162	15.87
1911	92.2	2,353	2,552	199	64.27
1912	82.2	1,828	2,223	395	50.56

[1] The estimate of value is on the basis of the farm value of hops in cents per pound, less 6 cents per pound for harvest costs. These farm values are officially estimated by the Bureau of Statistics, U. S. Dept. of Agriculture, as follows: 1909, 22.2 cents; 1910, 15.8 cents; 1911, 38.3 cents; 1912, 18.8 cents.

When the effect on yield of missing and unproductive hills is thus translated into terms of dollars and cents per acre, the results of inattention to proper cultural methods become very clear. The average loss on this acre for the four years 1909 to 1912 was $40, a sum certainly well in excess of that required to pay for the labor and supervision necessary to maintain a maximum percentage of productive stand.

SUGGESTED PROCEDURE FOR MAINTAINING A GOOD STAND.

Although some growers succeed in maintaining a practically perfect stand, others may fail to do so owing to causes clearly beyond their control. However, strict attention to the suggestions which follow will eliminate nearly all of those cases of missing or nonproductive hills which are due to carelessness or neglect. Such cases, as is shown on previous pages, are responsible for the greater part of the loss due to defective stand.

PRACTICAL SUGGESTIONS.

(1) Just before harvest time mark by means of stakes driven well into the ground all missing, "bastard," and excess male hills. After harvest dig out these hills and leave an open excavation at least 3 feet across and 2 feet deep.

(2) At pruning time dig out all hills that have died during the winter; then, before replanting, fill the site of all excavated hills with fresh soil mixed with manure.

(3) If possible, replant early while the soil contains an abundance of moisture to support the growth of the cuttings; cuttings planted in dry soil or sand should be well watered when they are set out.

(4) In replanting use only sound, vigorous cuttings taken from high-yielding hills and see that the cuttings are not allowed to dry out before planting.

(5) After the plants are well started inspect the hills carefully and replace all weak or dead plants with vigorous reserve plants from the nursery.

(6) Personally supervise the work of replanting, especially when it is done under contract or when immigrant labor is employed.

(7) In pruning, carefully distinguish (a) normal, well-developed stocks, which may be cut back either quite close to the crown or so as to leave only the first set of eyes on the stumps of the vines of the previous year, and (b) small, weak stocks, which should be so cut that two or even three sets of eyes will be left on the stumps of the vines.

(8) See that the vines are properly tied up, so that they will not be caught and broken or torn down by the implements used in cultivating or spraying.

(9) Keep a constant oversight of the fields and whenever a vine is torn down or falls to the ground see that it is immediately replaced on its proper support.

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BUREAU OF PLANT INDUSTRY—Circular No. 56.

B. T. GALLOWAY, Chief of Bureau.

SOME CONDITIONS INFLUENCING THE YIELD OF HOPS.

BY

W. W. STOCKBERGER, Pharmacognosist,

AND

JAMES THOMPSON, Expert,

Drug-Plant Investigations.

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Chief of Bureau, BEVERLY T. GALLOWAY.
Assistant Chief of Bureau, G. HAROLD POWELL.
Editor, J. E. ROCKWELL.
Chief Clerk, JAMES E. JONES.

B. P. I.—562.

SOME CONDITIONS INFLUENCING THE YIELD OF HOPS.[a]

INTRODUCTION.

In certain of the hop-growing sections of the United States the opinion is frequently expressed that there has been a progressive decline in the annual average yield per acre extending over a term of years. In other sections growers believe that the yields are at least as great now as they have ever been. Some support for each view is found in Table I, adapted from Bulletin No. 50 of the Bureau of Statistics, U. S. Department of Agriculture.

TABLE I.—*Average yield of hops, by States, for the census years 1880, 1890, and 1900.*

State.	Average yield per acre.		
	1880.	1890.	1900.
	Pounds.	*Pounds.*	*Pounds.*
California	1,291	1,648	1,469
New York	554	547	630
Oregon	804	1,155	951
Washington	1,317	1,626	1,287

[a] This paper clearly illustrates the importance of applying exact methods in studying the factors influencing crop yields. The facts here set forth were obtained from a study of the yield of hops, and they offer suggestions of great practical importance to every hop grower. It is desirable to emphasize the point that the most profitable methods of culture and handling can not be accurately determined by general observation alone, since many details will be overlooked which, apparently trifling in themselves, become of great importance when taken in the aggregate. For example, the direct loss due to the lack of a stand alone may not be appreciated until a survey is made and the percentage ratio determined.

The practical points presented in this publication were developed in connection with an extended investigation of American hop growing and handling which is being carried on by Dr. W. W. Stockberger, Pharmacognosist, assisted by Mr. James Thompson, expert, under the general direction of Dr. R. H. True, Physiologist in Charge of Drug-Plant Investigations, and it seems desirable to make these results immediately available in the form of a circular.—G. H. POWELL, *Acting Chief of Bureau.*

The figures given in this table were taken at ten-year intervals, and in the absence of those for the intervening years they are of little value in determining either an increase or a decrease in the average annual yield. Assuming, however, that the apparent diminution of yield for the State of California as indicated by the table was real, a thorough study of an individual acre in the central part of the State was begun in 1909 for the purpose of determining some of the factors which might be responsible for diminished production.

The results of this study clearly indicate that closer attention to certain cultural details should result in a substantial increase in yield.

THE METHODS EMPLOYED IN THE INVESTIGATION.

The acre selected for study represented, as far as inspection alone could determine, the average of conditions existing in several contiguous fields of hops aggregating about 600 acres. The soil, a rich sandy loam, had been under hops continuously for the last ten years. The rows were 7 feet apart, running from east to west, and the hills were approximately 6½ feet apart in the rows. The hops were trained on strings about 18 feet long, depending from the wires of the usual type of high-wire trellis.[a]

When the crop was ready for harvesting, a plat was made of the entire acre and a definite number assigned to every hill. The hops were then picked from each hill separately, weighed, and the weight recorded opposite the number assigned to that respective hill. The number of vines to the hill, the occurrence of male, dwarf, "bastard," nonproductive, and missing hills, and the general characteristics of the product of each hill were also recorded.

EFFECT OF IMPERFECT STAND ON YIELD OF HOPS.

When the observations were tabulated it became evident that the yield had been heavily reduced through the occurrence of a large number of nonproductive and missing hills, as will be seen from the following:

Hills producing hops	853
Hills having vines with no hops	42
Missing hills	56
Hills with dwarfed vines	1
Hills having "bastard" vines	5
Hills having only male vines	10
Total	967

Deducting the number of male hills, the presence of which is held to be necessary for the proper development of the crop, there should have been on this acre 957 productive hills, as against 853 hills

[a] See Farmers' Bulletin 304, p. 14.

actually bearing hops. This gives an absolute reduction of 104 hills, or 10.8 per cent. Had the entire number of hills been in bearing the yield would have been 12.1 per cent greater than that actually obtained.

The distribution of the hills having vines with no hops and of the missing hills is shown on the accompanying diagram (fig. 1). The

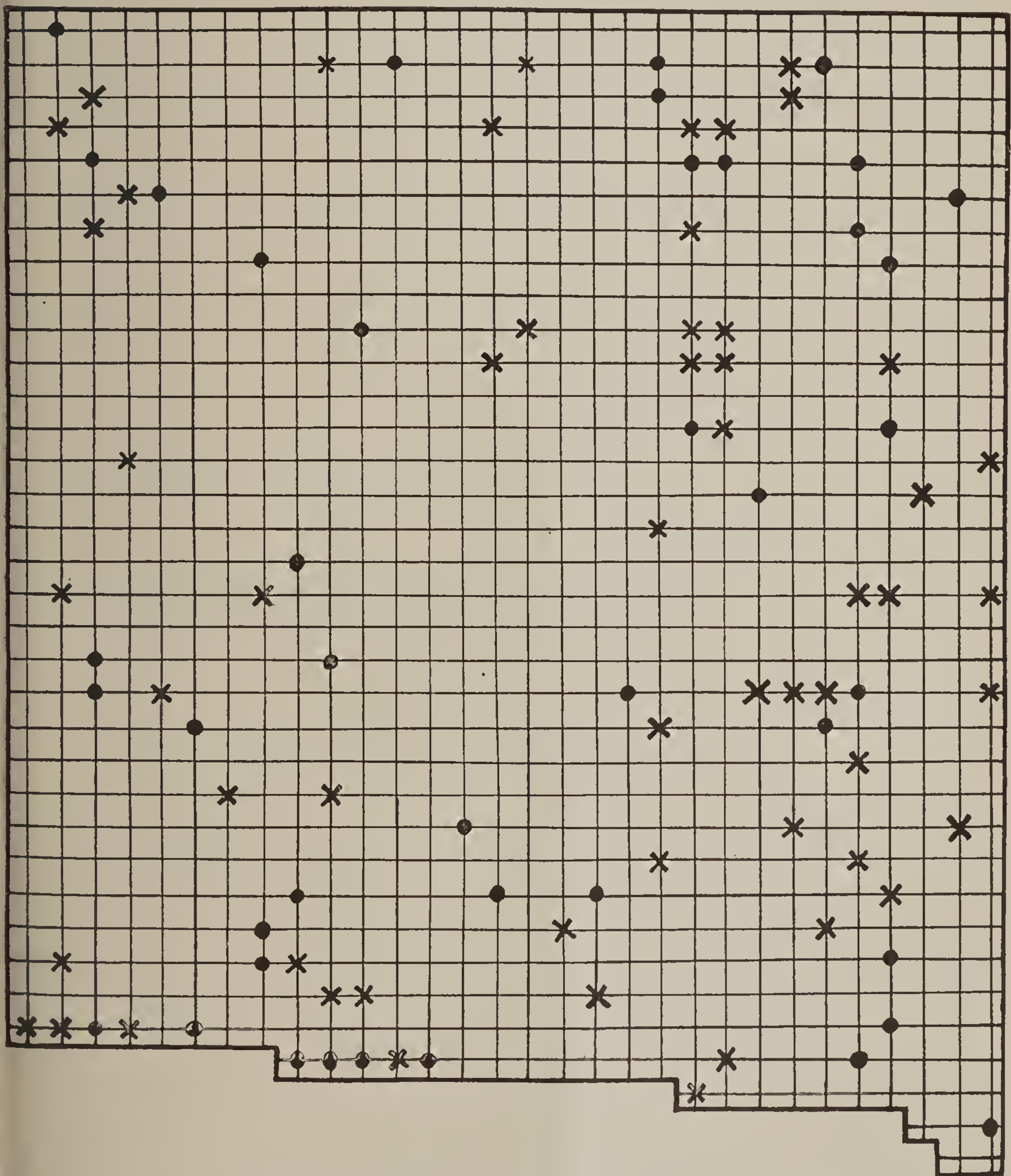

Fig. 1.—Diagram showing the distribution of nonproductive and missing hills of hops on the experimental acre in California. ● = Vines bearing no hops; X = missing hills.

dots indicate the hills having vines bearing no hops, and the crosses the missing hills. This distribution appears to be entirely one of chance and not due to variation in the soil, imperfections in the drainage, or other purely local factors.

VARIATION IN THE YIELD FROM INDIVIDUAL HILLS.

A wide variation was observed in the yield from individual hills. This ranged from a few ounces in some cases to as much as 18 pounds in others. In making the records the weight of green hops was taken to the nearest half pound, and the results have been put in tabular form, appearing in Table II. In the columns marked "Yield" the weight of green hops is given to the nearest half pound, and in the other two columns is given the number of hills, each of which gave the yield opposite these numbers in the adjacent column to the left.

TABLE II.—*Number of hills giving various yields of hops on the experimental acre in California.*

Yield.	Hills.	Yield.	Hills.
Pounds.	*Number.*	*Pounds.*	*Number.*
0.5	18	9.5	24
1.0	50	10.0	31
1.5	34	10.5	16
2.0	39	11.0	24
2.5	33	11.5	10
3.0	32	12.0	20
3.5	43	12.5	5
4.0	41	13.0	7
4.5	35	13.5	6
5.0	60	14.0	11
5.5	44	14.5	3
6.0	44	15.0	2
6.5	21	15.5	1
7.0	49	16.0	0
7.5	36	16.5	0
8.0	46	17.0	1
8.5	25	17.5	1
9.0	38	18.0	3

The total yield of this acre was 5,207.5 pounds of green hops, and this divided by 853, the number of bearing hills, gives 6.104+ pounds as the average production per hill. Of the entire number of hills, 473 were below the average and 380 hills were above the average production. Also, the average production is only one-third of that reached in the case of a few hills.

According to the quantity of hops produced the hills may be roughly divided into three classes, or groups: (1) Those yielding less than 6 pounds, (2) those yielding from 6 to 12 pounds, and (3) those yielding more than 12 pounds. The first group consists of 429 hills, or 50.1 per cent of the entire number, and these produced only 1,380.5 pounds, or 26.5 per cent of the entire yield. The second group has 384 hills, or 45 per cent of the entire number, and the production was 3,261 pounds, or 62.6 per cent of the entire yield. The third group consists of 40 hills, or 4.7 per cent of the entire number, and the hops produced weighed 566 pounds, being 10.8 per cent of

the entire yield. The accompanying figure (fig. 2) shows graphically the relationship between these three groups.

Figure 2 will serve, also, in forming some conception of type with respect to yield from the hills of an entire field. A study of the hills of group 1 shows that for various reasons they are less productive than those usually regarded as average or representative hills. Similarly, the hills of group 3 are few in number and may be considered as exceptional and their occurrence expected far less often than that

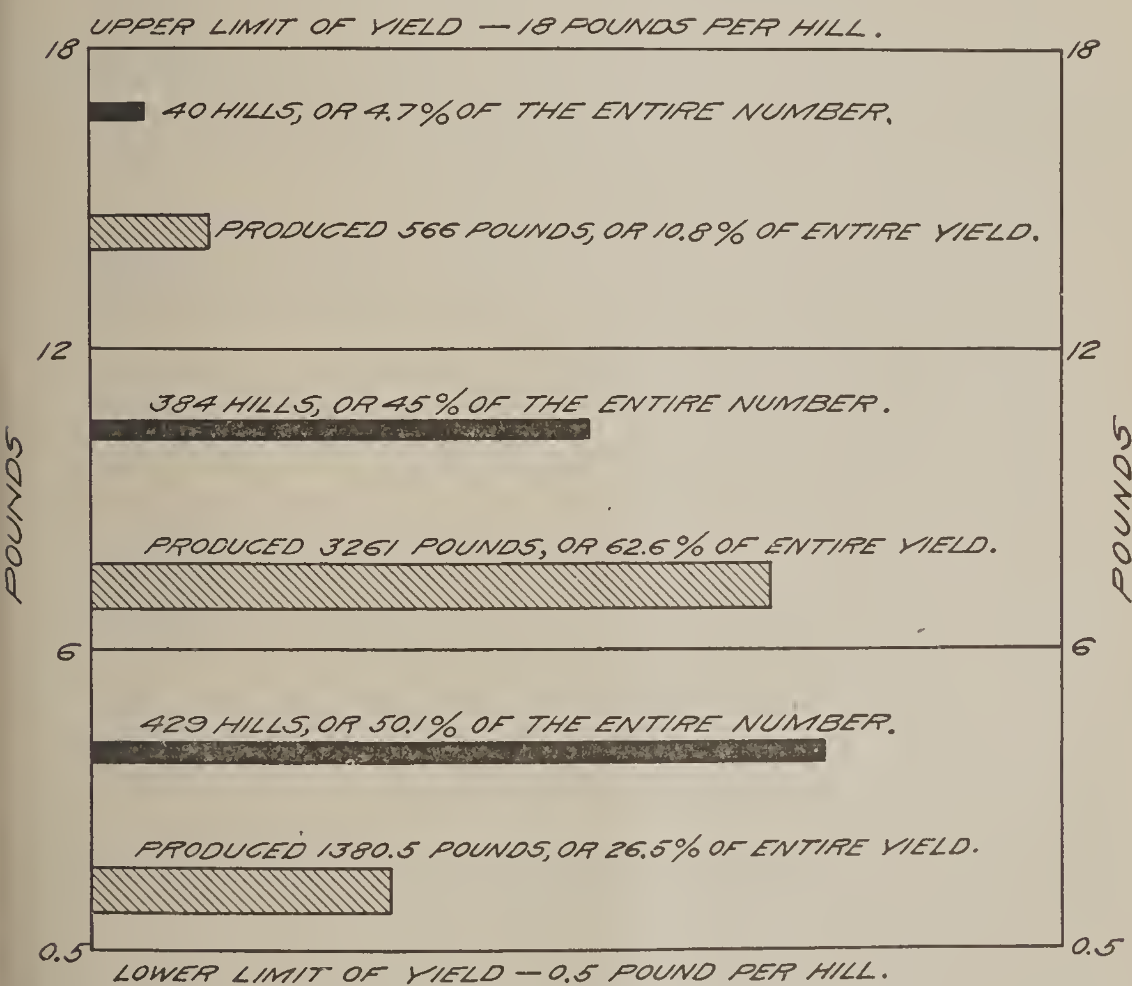

Fig. 2.—Diagram showing the ratio of the number of hills to the production of hops in three groups of low, medium, and high yielding hills.

of the hills of the other groups. It seems, therefore, that among the hills of group 2, where the bulk of the yield was obtained, the typical hills with respect to yield may be expected to occur. Assuming, then, that the prevailing type of normal hills with respect to yield lies between those producing 6 and those producing 12 pounds, there is every reason for giving special attention to the hills low in yield for the purpose of bringing them to a higher state of productiveness.

The fact should not be lost sight of that the average yield for this acre, 6.1+ pounds per hill, lies just above the lower limit of yield in

the second group. If through better methods of handling and closer attention to the details of culture the number of hills in the first group can be materially diminished, the average yield for the entire acre will be correspondingly advanced toward the upper limit of yield in the second group, and the total yield thereby substantially increased. In the following pages some suggestions will be given as to how this may be accomplished.

RELATION OF NUMBER OF VINES PER HILL TO YIELD.

The records obtained from the acre under observation show, further, that the number of vines trained from the individual hills varied from one to eight. The distribution of the hills according to the number of vines is shown in the following:

Hills having one vine	54
Hills having two vines	113
Hills having three vines	135
Hills having four vines	186
Hills having five vines	188
Hills having six vines	168
Hills having seven vines	8
Hills having eight vines	1
Total	853

Several explanations of the variation in vines to the hill may be advanced. Among them are the recent replanting of certain hills, in which case they would not have the vigor of older hills; the weakening of the roots of some hills by disease or the attacks of insects; the exhaustion of the vigor of others through long-continued production; the breaking off of a portion of the vines in cultivation; the destruction of some vines by the wind; or the cutting off of too many vines at the time of training. What seems most probable is that through the carelessness and negligence of the workmen the proper number of vines was not trained. It is probable, also, that individual differences in vigor and productiveness should be taken into account.

The relation between the number of vines per hill and the yield per hill is shown in Table III.

TABLE III.—*Comparison of the production of hops to the hill and the number of vines to the hill.*

Yield to the hill.	Number of vines to the hill—								Total number of vines.
	1.	2.	3.	4.	5.	6.	7.	8.	
Pounds.									
0.5	10	8	....	....	....	....	....	....	18
1.0	23	17	7	1	1	1	....	....	50
1.5	11	15	4	2	2	....	....	....	34
2.0	4	19	10	5	1	....	....	....	39
2.5	2	11	15	4	1	....	....	....	33
3.0	1	10	12	5	4	....	....	....	32
3.5	2	8	15	14	3	1	....	....	43
4.0	1	9	9	14	4	4	....	....	41
4.5	....	4	9	13	7	1	1	....	35
5.0	....	3	18	19	12	8	....	....	60
5.5	....	3	11	15	10	5	....	....	44
6.0	....	3	6	11	15	9	....	....	44
6.5	....	....	2	8	4	7	....	....	21
7.0	....	2	4	17	14	12	....	....	49
7.5	....	....	....	8	18	10	....	....	36
8.0	....	....	4	11	18	13	....	....	46
8.5	....	....	2	4	8	11	....	....	25
9.0	....	1	2	10	10	12	2	1	38
9.5	....	....	1	7	7	8	1	....	24
10.0	....	....	1	6	11	13	....	....	31
10.5	....	....	1	....	6	8	1	....	16
11.0	....	....	....	2	7	14	1	....	24
11.5	....	....	1	1	1	7	....	....	10
12.0	....	....	....	3	10	7	....	....	20
12.5	....	....	....	2	1	1	1	....	5
13.0	....	....	....	1	2	4	....	....	7
13.5	....	....	....	....	5	1	....	....	6
14.0	....	....	1	2	3	5	....	....	11
14.5	....	....	....	....	1	2	....	....	3
15.0	....	....	....	....	....	1	1	....	2
15.5	....	....	....	....	1	....	....	....	1
16.0	....	....	....	....	....	....	....	....	0
16.5	....	....	....	....	....	....	....	....	0
17.0	....	....	....	1	....	....	....	....	1
17.5	....	....	....	....	....	1	....	....	1
18.0	....	....	....	....	1	2	....	....	3
	54	113	135	186	188	168	8	1	853

In the first column of the table the yield per hill is given to the nearest half pound. The figures at the top of the following columns indicate the number of vines produced by each hill occurring therein, and the hills in each column are distributed according to their production to the nearest half pound. For example, from column 1 it will be seen that ten 1-vine hills produced 0.5 pound each, twenty-three 1-vine hills produced 1 pound each, etc.; from column 2 eight 2-vine hills produced 0.5 pound each, seventeen 2-vine hills produced 1 pound each; from column 3 seven 3-vine hills produced 1 pound each, four 3-vine hills produced 1.5 pounds each, and so on for the entire table. At the foot of the table the totals show the entire number of hills producing the number of vines indicated by the figure at the top of the respective columns.

A study of Table III will show that the larger numbers in each column occur in groups, but that the position of these groups with respect to the production per hill is very different. Thus (from column 1) 10, 23, and 11 hills produced 0.5, 1, and 1.5 pounds each.

respectively; (from column 3) 15, 12, and 15 hills produced 2.5, 3, and 3.5 pounds each, respectively; (from column 5) 14, 18, and 18 hills produced 7, 7.5, and 8 pounds each, respectively. From column 1 it appears that no 1-vine hill produced more than 4 pounds, and from column 6 that relatively few 6-vine hills produced less than 6.5 pounds each. The balance of evidence, therefore, is entirely in favor of a much larger total production when 6 vines to each hill are trained than with a smaller number.

COMPARISON OF ACTUAL WITH POSSIBLE YIELDS ON 1 ACRE.

The actual yield of hops on the acre studied was 5,207.5 pounds, and the mean yield per hill 6.104+ pounds. Had there been a full stand of 957 bearing hills, with this same average yield per hill, the production on the acre would have been 5,841.5 pounds. This is an increase of 12.1+ per cent over the actual yield.

In a similar manner, the possible yield per acre has been calculated for each number of vines trained per hill. For comparison the results have been brought together in Table IV, which follows:

TABLE IV.—*Possible yield on 1 acre of hops, according to the number of vines trained, with the corresponding increase or decrease of the possible over the actual yield.*

Number of vines to the hill.	Number of hills.	Actual yield.	Average yield to the hill.	Average yield to the vine.	Possible yield to the acre.	Increase or decrease of possible over actual yield.
		Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Per cent.*
1	54	71.5	1.324	1.324	1,257.0	[a] 75.8+
2	113	293.5	2.597	1.298	2,485.3	[a] 52.2+
3	135	585.5	4.337	1.445	4,150.5	[a] 20.2+
4	186	1,168.0	6.279	1.569	6,009.0	[b] 15.3+
5	188	1,488.5	7.917	1.583	7,576.5	[b] 45.4+
6	168	1,510.5	8.991	1.498	8,604.3	[b] 65.2+
7	[c] 8	81.0	10.125	1.446		
8	[c] 1					

[a] Decrease. [b] Increase. [c] Number of hills too small for consideration.

The average yield to the hill was determined in each case by dividing the number of pounds produced by all of the hills having the same number of vines by the number of such hills. The possible yield was then obtained by multiplying the average yield per hill by 957, the number of possible bearing hills to the acre. It will be observed that the possible yield in the case of the hills having 1, 2, and 3 vines, respectively, is very much less than the actual yield, which was 5,207.5 pounds. Also, in the case of the hills having 4, 5, and 6 vines, respectively, the possible yield is far in excess of the actual, being 65.2+ per cent greater for the 6-vine hills.

It should be noted that the average yield per vine is fairly constant, irrespective of the number of vines to the hill. The average yield per vine for the entire acre also closely accords with these figures, being in this case 1.513 pounds per vine.

The averages given in Table IV may be considered as applying not only to the acre studied, but also in a general way to the entire crop in the section where this work was done. So long as the general conditions remain unchanged there is a high degree of probability that these averages will be found to represent fairly well what may be expected in succeeding years. Changed weather conditions, attacks of lice, mold, and spiders, or other unfavorable influences to which the hop crop is subject, will of course materially affect the chance of these averages being repeated. But they do show that a great increase in yield may be reasonably anticipated in fields in which there is a full stand and 6 vines are trained to each hill over the entire field when it presents the conditions existing on the acre which has furnished the data for these observations.

THE SO-CALLED "BASTARD" VINES.

In some sections hop vines are occasionally found which bear both staminate and pistillate flowers. Such plants are known locally as "bastards," "mongrels," or "bull-hops." When they occur they represent a total loss, so far as yield is concerned, since the few hops borne by these vines are inferior and never gathered. On the acre under consideration there were only five of these plants, but they have been observed in much greater proportion in other years and in other localities.

There is no evidence that these vines usually occur near a male vine, as stated by Myrick;[a] neither can an excess of pollen falling upon the pistillate flowers produce this abnormality, as is believed by some to be the case. Plants of this type frequently occur among seedling hops, and their presence may be expected in fields where chance seedlings springing up near the permanent hills have been trained in the usual manner. There are also good reasons for believing that this undesirable characteristic may be introduced through the root cuttings used in replanting or in setting out new fields. In 1908 a number of cuttings were taken from one of these "bastard" plants and removed to a locality about 40 miles distant. The vines from these cuttings came into flower in 1909 and in every case reproduced the malformation of the original plant from which they were taken. In view of this fact care should be taken to prevent the use of cuttings from "bastard" plants by promptly digging them out and destroying

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[a] Myrick, H. The Hop, New York, 1899, p. 23.

the roots as soon as they are observed. In this way their perpetuation may be prevented and the loss in yield due to their occurrence avoided.

SUMMARY.

A critical study of yield on an acre of hops in California selected as representing the average condition of 600 surrounding acres shows that, owing to the occurrence of a large number of nonproductive and missing hills, the actual yield was only 87.9 per cent of what might be expected with a perfect stand.

The yield from individual hills was found to vary from 0.5 to 18 pounds. Owing to the large number of low-yielding hills the average yield per hill for the entire acre was reduced to 6.104+ pounds.

The number of vines trained to each hill varied from one to eight. As the number of vines per hill increased, the average yields of the hills having the same number of vines were found to increase in approximately the same ratio.

Assuming a full stand of 957 hills with 6 vines trained to each hill, the calculated possible yield is 65.2+ per cent greater than the actual yield on this acre.

"Bastard" or "mongrel" hills should be dug out and destroyed, as they are of no value and diminish the total yield.

Approved:

JAMES WILSON,

Secretary of Agriculture.

WASHINGTON, D. C., *March 7, 1910.*

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BUREAU OF PLANT INDUSTRY—BULLETIN NO. 271.

B. T. GALLOWAY, *Chief of Bureau.*

SOME EFFECTS OF REFRIGERATION ON SULPHURED AND UNSULPHURED HOPS.

BY

W. W. STOCKBERGER, *Physiologist,*

AND

FRANK RABAK, *Chemical Biologist,*

Drug-Plant, Poisonous-Plant, Physiological, and Fermentation Investigations.

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DRUG-PLANT, POISONOUS-PLANT, PHYSIOLOGICAL, AND FERMENTATION INVESTIGATIONS.

SCIENTIFIC STAFF.

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A. B. Clawson, Heinrich Hasselbring, C. Dwight Marsh, W. W. Stockberger, and Walter Van Fleet, *Physiologists.*

Carl L. Alsberg, H. H. Bartlett, Otis F. Black, H. H. Bunzel, Frank Rabak, and A. F. Sievers, *Chemical Biologists.*

W. W. Eggleston, *Assistant Botanist.*

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
OFFICE OF THE CHIEF,
Washington, D. C., September 18, 1912.

SIR: I have the honor to transmit herewith and to recommend for publication as Bulletin No. 271 of the series of this Bureau a manuscript by Dr. W. W. Stockberger, Physiologist, and Mr. Frank Rabak, Chemical Biologist, entitled "Some Effects of Refrigeration on Sulphured and Uusulphured Hops," submitted by Dr. R. H. True, Physiologist in Charge of the Office of Drug-Plant, Poisonous-Plant, Physiological, and Fermentation Investigations.

In this paper is discussed some of the changes which occur in important constituents of hops under different conditions of storage and a comparison is made of the relative efficacy of certain methods for preventing undesirable changes in hop constituents.

This bulletin shows that both refrigeration and sulphuring retard changes in the volatile constituents of hops and that the determination of the value of hops from the aroma varies according to individual preference for or dislike of one or the other of the aromatic constituents. The conclusions drawn from a comparison of valuations made from both physical and chemical standpoints will be of practical importance to all interested in the hop industry.

Respectfully,

B. T. GALLOWAY,
Chief of Bureau.

HON. JAMES WILSON,
Secretary of Agriculture.

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SOME EFFECTS OF REFRIGERATION ON SULPHURED AND UNSULPHURED HOPS.

INTRODUCTION.

Opinions are greatly divided as to the desirability or general expediency of the practice of treating hops with the fumes of burning sulphur during the process of drying. This process, which in the United States is termed "sulphuring," has been long in vogue and has come to be regarded as an essential part of the method of preparing hops for market. The use of sulphur as an adjunct to hop drying apparently originated in England and from the first was regarded as a more or less effective means of checking the tendency of newly packed hops to heat and spoil in the bale. Later, other virtues were claimed for sulphuring in addition to that of preservative action, and those who advocate the use of sulphur now believe that it favorably affects the hops by changing and improving the color, by hastening the drying through causing the rapid death of the cells, and by preventing fermentation, thereby improving the keeping qualities.

Aside from sulphuring, a number of other expedients have been resorted to for the purpose of delaying or retarding the changes which normally occur in the chemical constituents of hops after they have been dried and baled. Of these expedients refrigeration is the most widely used and from many considerations it is perhaps the most efficient and generally satisfactory method of preservation that has as yet been employed.

The sulphuring of hops is such a common practice in the United States that practically all hops placed in cold storage may be regarded as having absorbed a varying quantity of sulphurous acid, depending to a certain extent upon the quantity of sulphur used at the time of drying. Since both sulphuring and cold storage are held to be efficient agents in retarding changes in the essential constituents of hops, the diminished rate of deterioration of sulphured hops in cold storage must be due to the combined action of these two processes. However, the relative efficacy of these two processes,

or the extent to which the one or the other alone would accomplish the desired result, is usually a subject of approximate estimation only.

For the purpose of obtaining some experimental data upon the preservative action on hops of sulphuring and cold storage, singly and in combination, suitable material was prepared and held under observation for several years. The results of this study, which are given in some detail in this bulletin, indicate that both cold storage and sulphuring tend to delay certain undesirable chemical changes and that the usual trade judgment can not always be relied upon to give an accurate measure of the extent to which these changes have occurred. However, it is fully realized by the writers that further experimentation is necessary before the conclusions drawn from this work can be considered to have a general application.

PREPARATION OF THE HOPS STUDIED.

The hops which furnished the materials for the observations here recorded were all picked from the same part of a field on a hop ranch in the Sacramento Valley on August 30, 1907, and were dried on the same day under the senior writer's supervision. As the hops were received from the field they were equally distributed to two duplicate stove kilns until each had received a load of about 4,500 pounds, green weight. The fires were lighted and the temperature of each kiln was gradually raised to a point between 130° and 140° F., between which limits it was maintained until the drying was completed. On one of these kilns 110 pounds of sulphur was burned under the hops during the drying, which required 13 hours; on the other kiln no sulphur was used and the time required for drying was 18 hours. The dry hops from each of these two kilns were separately deposited in the cooling room and on September 2 two bales of the usual commercial type were prepared from the unsulphured hops and two from those which had been heavily sulphured. These four bales were conveyed to Sacramento, where two bales, one of sulphured and one of unsulphured hops, were placed in cold storage at 36° F. in the hop storeroom of the Buffalo Brewing Co., and the two remaining bales, one of which was sulphured and one unsulphured, were placed in ordinary storage in the Clunie warehouse.

PHYSICAL CHANGES IN THE HOPS IN COLD AND IN ORDINARY STORAGE.

As a rule, it is difficult to correlate the valuation of hops as determined from their physical characters with the indications of their value derived from chemical analysis. In the present case, however,

some chemical determinations were made which are not ordinarily taken into account in analyzing hops, and the results furnish some interesting parallels when compared with the relative rank in quality of the four bales of hops as fixed by physical valuation.

In order to have the differences in physical condition expressed in the language of the trade and as nearly as possible from the trade viewpoint, samples were drawn from time to time from the four bales and submitted to various trade experts, who were asked to report their impressions as to the general condition and relative merit of the various samples.

Early in April, 1908, after the hops had been in storage for seven months, samples were drawn from each of the four bales and submitted to five trade experts, all of whom concurred in the following report made by one of their number:

We have examined these samples as to their condition at the present time to see if there was any difference between cold and regularly stored hops, and we are of the same opinion that there is no difference between the cold-stored and regularly stored hops.

The bales were not sampled a second time until midsummer, and during the time which had elapsed since the first sampling the hops in ordinary storage had been subject to the influence of the hot and dry weather which prevails in the Sacramento Valley at this season of the year. Naturally, it was expected that at this time certain differences would be apparent in the hops under different conditions of storage. On July 24, 1908, samples were drawn and submitted to an expert hop buyer, who reported on them as follows:

Unsulphured cold-stored hops.—Fine fresh hop flavor; good oily feeling; aroma almost as good as new hops and seems to be about the same as that of the sulphured cold-stored hops.

Sulphured cold-stored hops.—Fine fresh hop flavor; good oily feeling; aroma almost as good as new hops, but color somewhat lighter than the color of the unsulphured sample above described.

Unsulphured ordinary-stored hops.—Flavor decidedly that of old hops as compared with the cold-stored samples; feeling dry; lupulin not very sticky; color about the same as the color of the unsulphured sample above.

Sulphured ordinary-stored hops.—Fine fresh flavor; good oily feeling; aroma almost as good as new hops, but the color somewhat lighter than the color of the unsulphured sample above described.

At this time it is decidedly noticeable that the cold-stored hops have by far the best flavor and that they feel almost as oily as new hops, while the ordinary-stored hops are becoming poorer.

This judgment was taken within an hour after the bales had been sampled, and on coming into the room where the samples had been placed I thought that the excellent aroma was due to new hops. I was really surprised at the great difference in the aroma between the ordinary-stored and cold-stored hops, but

on comparing color I can not notice any serious difference between sulphured and unsulphured hops in either case.

These same samples were next submitted to a second expert, who made the following statement:

The difference between the ordinary-stored and the cold-stored hops is now very noticeable. The unsulphured cold-stored sample has a very good flavor and looks fresh and bright. The unsulphured ordinary-stored sample has not such a good flavor as the former, is very much drier, and is becoming rapidly aged. The difference between these two is particularly noticeable in the appearance of the sides of the samples, the side of the cold-stored sample showing up much brighter and fresher than that of the other.

The sulphured cold-stored sample has a fine fresh flavor and is a particularly well-kept hop, while the sulphured ordinary-stored sample has a musty, old flavor and is rather dried out. The difference between these two samples is not so much in the appearance as in the aroma.

On the day following, these samples were submitted to a brewmaster, who delivered the following opinion:

The cold-stored hops have a lighter color as compared with the ordinary-stored hops, the lupulin is bright and shiny, the hops have a very oily and sticky feeling, and the aroma is almost like that of new hops.

The ordinary-stored hops have a dull, dry color; the lupulin is not so bright and appears to be hard and dry, with very little oil as compared with the cold-stored hops; the flavor is decidedly different and very much like that of old hops.

The bales were not sampled again until February 13, 1909, eighteen months after they were first placed in storage. The samples drawn on this date were first submitted to the brewmaster previously mentioned, and his judgment as to their relative merit was stated thus:

The sulphured and unsulphured cold-stored samples are respectively superior in flavor to the corresponding ordinary-stored samples. The sulphured samples in cold and ordinary storage are far superior both in flavor and color to the unsulphured samples.

The samples were next submitted to a trade expert, who gave the following opinion:

There is a very great difference between the cold-stored and ordinary-stored hops. The cold-stored samples are much brighter in appearance, have much more flavor, contain much more moisture, and their lupulin is much brighter than the ordinary-stored samples. The cold-stored samples would pass for new hops, while the ordinary-stored samples show their age and could not pass for anything else than "olds." By new hops I mean the 1908 crop.

Of the cold-stored hops the unsulphured sample seems to have a trifle more flavor than the sulphured one, but the latter has a sweeter flavor, which I believe would be preferred. The lupulin in both these samples is very fresh and moist, but that in the sulphured sample is a trifle the brighter. The sulphured sample, though in appearance fresher than the unsulphured sample, is not as moist as the latter.

Of the ordinary-stored hops the unsulphured sample has much more flavor than the sulphured sample, the latter having very little flavor at all. The

lupulin in the sulphured sample is a trifle brighter than that in the other. The unsulphured sample is much more moist than the sulphured sample, though the latter, before a detailed examination, appears to be the fresher of the two, a condition that can be traced to the brightening effect of the sulphur.

Since the sulphured cold-stored hops naturally conformed most closely in appearance and general condition to the hops usually found in the trade it was expected that they would be ranked first in quality, and such proved to be the case when the several expressions of judgment by the trade experts were analyzed. With respect to the other lots of hops, however, opinion was divided and the usual differences in trade judgment of quality are here well illustrated. The rank in order of merit as fixed by four of the judges was as follows:

Sulphured cold-stored hops	1,	1,	1,	1.
Unsulphured cold-stored hops	2.	2.	3,	2.
Sulphured ordinary-stored hops	3.	4.	2,	4.
Unsulphured ordinary-stored hops	4.	3.	4,	3.

CHANGES IN THE VOLATILE CONSTITUENTS OF HOPS IN COLD AND IN ORDINARY STORAGE.

On September 10, 1909, portions of the four bales of hops under consideration were withdrawn from storage and subjected to steam distillation to remove the volatile oils, which were then dried and purified and later examined to determine their degree of acidity and ester content. These factors, together with the percentage of yield of volatile oil, are given in Table I.

TABLE I.—*Comparison of volatile oils from sulphured and unsulphured hops in cold and in ordinary storage for two years.*

Source of oil examined.	Percentage of oil.	Acid number.	Ester number.
Sulphured cold-stored hops	0.12	7.3	78
Unsulphured cold-stored hops	.12	9.0	103
Sulphured ordinary-stored hops	.06	12.5	96
Unsulphured ordinary-stored hops	.05	15.6	151

An inspection of this table reveals the following interesting facts:

(1) The yield of oil is twice as great in the cold-stored hops as in those in ordinary storage.

(2) The acidity of the oil from the cold-stored hops is far less than that of the hops in ordinary storage.

(3) The oil from the sulphured hops in ordinary storage shows an increase of 71.2 per cent in acidity over that from the hops in cold storage, while the oil from the unsulphured hops in ordinary storage shows an increase of 73.3 per cent in acidity over that of the oil from those in cold storage.

(4) The oil from the unsulphured cold-stored hops shows an increase of 23.2 per cent in acidity over that from the hops that were sulphured, while the oil from the unsulphured, ordinary-stored hops shows an increase of 24.8 per cent in acidity over that from the hops that were sulphured.

(5) The oil from the unsulphured ordinary-stored hops shows an increase of 113.6 per cent in acidity over the oil from sulphured cold-stored hops.

(6) The ester content of the oil from the sulphured hops is much less than that of the oil from the unsulphured hops.

(7) The oil from the unsulphured ordinary-stored hops shows an increase of 23 per cent in ester content over that from the hops in cold storage, while the oil from the unsulphured hops in ordinary storage shows an increase of 46.6 per cent in ester content over the oil from those in cold storage.

(8) The oil from the unsulphured cold-stored hops shows an increase of 32 per cent in ester content over the oil from the sulphured cold-stored hops, while the oil from the unsulphured ordinary-stored hops shows an increase of 57.2 per cent in ester content over that from the sulphured hops in ordinary storage.

(9) The oil from the unsulphured ordinary-stored hops shows an increase of 93.5 per cent in ester content over that of the oil from the sulphured cold-stored hops.

This analysis gives an index of the relative efficacy of sulphuring and cold storage in controlling changes in acidity and ester content of the hop oils during the first two years of storage. The percentages of increase in acidity as between cold and ordinary storage are approximately three times the corresponding increase as between the sulphuring and nonsulphuring. This would apparently indicate that cold storage is three times as effective as sulphuring in retarding increase in acidity. With respect to ester content, the increase, as between the oils from cold and ordinary stored hops, is twice as great in unsulphured as in sulphured hops; also as between sulphured and unsulphured hops the increase in the ester content of the oil is twice as great in ordinary storage as in cold storage. This would seem to show that cold storage and sulphuring are about equally effective in retarding the increase in the ester content and that the two combined exert double the effect of either acting alone.

On December 1, 1910, fifteen months later, a second set of samples was taken from the four bales in storage and the volatile oils removed by distillation. The results of the examination of these oils, which are given in Table II, show little harmony with those of the first analysis.

TABLE II.—*Comparison of volatile oils from sulphured and unsulphured hops in cold and in ordinary storage for three years and three months.*

Source of oil examined.	Acid number.	Ester number.
Sulphured cold-stored hops	30.8	129.5
Unsulphured cold-stored hops	33.1	126.1
Sulphured ordinary-stored hops	24.0	105.0
Unsulphured ordinary-stored hops	24.0	109.0

An inspection of the table shows in this case the following relations:

(1) The acidity of the oil from the cold-stored hops is greater than that of the oil from the hops in ordinary storage.

(2) The acidities of the oils from the hops in ordinary storage are the same.

(3) The oils from the unsulphured cold-stored hops are highest in acidity.

(4) The ester content of the oils from the cold-stored hops is greater than that of the oils from the ordinary-stored hops.

(5) The oils from the sulphured hops in cold storage are highest in ester content.

(6) The oils from the unsulphured hops in cold and in ordinary storage, respectively, are higher in ester content than the oil from the sulphured hops in ordinary storage.

It is now evident that the apparent effects of sulphuring and cold storage as shown by the second analysis are almost the reverse of those indicated by the first analysis. How these seeming discrepancies may be harmonized can be seen from an inspection of Table III, in which the results of the two analyses are directly compared.

TABLE III.—*Comparison of the acidity and ester content of the oils from sulphured and unsulphured hops in cold and in ordinary storage.*

Kind of storage.	Sulphured hops.						Unsulphured hops.					
	Acid number.		Percentage of increase, 1910.	Ester number.		Percentage of increase, 1910.	Acid number.		Percentage of increase, 1910.	Ester number.		Percentage of increase, 1910.
	1909	1910		1909	1910		1909	1910		1909	1910	
Cold	7.3	30.8	321.9	78	129.5	66.0	9.0	33.1	267.4	103	126.1	22.4
Ordinary	12.5	24.0	92.0	96	105.0	9.3	15.6	24.0	53.8	151	109.0	7.7

Regarding, first, the acidity, the data in this table show that the percentage of increase in acidity was least in the oils from the hops which yielded oils that were highest in acidity in 1909 and greatest

in those lowest in acidity in 1909. Further, all the percentages of increase in acidity in 1910 are inversely proportional to the acidities in 1909. It is evident from the first analysis that the rate of change in the volatile constituents under consideration was greatest in the oils from the unsulphured hops in ordinary storage. These changes would continue until a maximum was reached, after which, owing to the interaction between the oxidation products of the various organic constituents of the hops and to the direct loss through volatilization, a decline in acidity would be the normal result. Assuming that this maximum was reached between the time of the first and the second analysis and applying this explanation to the data on acidity in Table III, the oils from the hops in ordinary storage may be regarded as having passed the maximum and as being in the declining phase with respect to acidity. Since the changes in the unsulphured hops in ordinary storage were not artificially retarded, the oils from these would naturally be nearer than the others to the maximum acidity at the time of the first analysis, and hence the percentage in increase in 1910 would be smallest.

Of the hops in cold storage, the oils from those that were unsulphured may be regarded as being at or near the maximum of acidity in 1910, thus accounting for the high figure of actual acidity and for the relatively large percentage of increase in acidity during this year. On the other hand, the oils from the sulphured cold-stored hops had apparently not reached the maximum acidity in 1910, owing to the slower rate of change in acidity in these oils due to the combined effect of sulphuring and cold storage. When viewed from this standpoint, the apparent discrepancy between the two analyses disappears and the balance of evidence is in favor of the conclusion (1) that under the four conditions of this experiment the acidity of the oil of hops increases to a maximum and then declines; (2) that sulphuring and cold storage merely retard but do not inhibit changes in acidity; and (3) that sulphuring and cold storage combined are more effective in retarding changes in acidity than either alone.

With respect to the esters, the data indicate that, in general, the changes in ester content have been similar to the changes in the acidity, although complicated by some other factors which make the relations of these changes to the conditions of storage less clear. The first analysis shows that the greatest changes in ester content occurred in the oils from the unsulphured hops and also that the oils from the hops in ordinary storage had undergone a greater change than the corresponding oils from the sulphured and unsulphured hops, respectively, in cold storage. It is possible that the

sulphur inhibits the development of ester beyond a certain point, in which case two maxima might be expected—one for the oil from sulphured hops and a higher one for the oil from unsulphured hops. The data of Table III agree with this assumption, for it appears that the oils of the unsulphured ordinary-stored hops were at or near the maximum of ester content in 1909, which thereafter rapidly declined, as shown by the figure reached in 1910.

The oil from the unsulphured cold-stored hops, which was below the probable maximum of ester content at the time of analysis in 1909, shows an apparent increase of 22.4 per cent in 1910; but, since the figure reached in 1910 is less than the probable maximum as indicated by the ester content of the oils from the hops in ordinary storage in 1909, it seems evident that the oils in the hops in cold storage had reached the maximum and entered upon the declining phase before the analysis in 1910. This view receives further support from the fact that the oil from the sulphured cold-stored hops, in which the chemical changes were most retarded, was higher in ester content in 1910 than the oil from those which were unsulphured.

The oils of the sulphured hops in ordinary storage appear to have passed their maximum of ester content and to be in the declining phase in 1910, while those of the hops that were sulphured and which show the greatest increase in ester content in 1910 appear to be at or near their maximum. The conclusions which are to be drawn with respect to the ester content, therefore, are that sulphuring retards the increase in ester content and inhibits it beyond a certain maximum, that cold storage retards but does not inhibit increase in ester content, and that sulphuring and cold storage combined are more effective in retarding changes in ester content than either alone.

CHANGES IN THE HOP RESINS.

In further pursuance of the plan of securing trade opinions with respect to the changes which had taken place in the four bales of hops under different conditions of treatment, portions of these bales were sent to a firm which is a large consumer of hops, with the request that the content of soft and hard resins be determined in each. The first analysis was made by the chemist of this firm in January, 1910, two years and four months after the bales had been first placed in storage. One year later a second lot of samples was sent to the same chemist and by him duly analyzed. The results of these two analyses are given in Table IV.

TABLE IV.—*Changes in resin content in sulphured and unsulphured hops in cold and in ordinary storage.*

Previous treatment of the hops analyzed.	Percentage of resins.					
	Soft resins.		Hard resins.		Total resins.	
	1910	1911	1910	1911	1910	1911
Sulphured, cold stored	10.5	10.3	5.5	5.6	16.0	15.9
Unsulphured, cold stored	10.6	8.7	5.3	6.2	15.9	14.9
Sulphured, ordinary stored	9.9	7.5	5.5	7.5	15.4	15.0
Unsulphured, ordinary stored	9.9	7.8	7.0	6.4	16.9	14.2

The figures in the foregoing table give an index to the changes which occurred in the resin content of these hops during the third year of storage. The slightest change in total resins, 0.1 per cent, took place in the sulphured cold-stored hops, while the greatest change, 2.7 per cent, is evident in the unsulphured hops in ordinary storage. The loss in soft resins was least in the sulphured cold-stored hops, 0.2 per cent, and greatest in the sulphured ordinary-stored hops, 2.4 per cent. The loss in soft resins of the unsulphured hops was 1.9 per cent in cold storage and 2.1 per cent in ordinary storage. As far as the evidence from these analyses goes, it indicates that sulphuring diminishes the loss of total resins, but does not diminish the loss of soft resins except when followed by cold storage. The greatest loss in soft resins was in the sulphured hops in ordinary storage, and, since the soft resins alone are intrinsically valuable, from this standpoint these hops must be regarded as the poorest of the lot. With respect to these particular samples, the balance of evidence indicates that there is a distinct advantage in both sulphuring and cold storage. However, the margin of difference in the results of the analyses is relatively small, and if the soft resins were regarded as the only measure of value, the advisability of incurring the expense of long-continued cold storage might be questioned.

PHYSICAL AND CHEMICAL VALUATION COMPARED.

Great difficulty is experienced not only in harmonizing the results of the physical and chemical estimations of the value of hops, as pointed out on a previous page, but also in bringing into accord the different individual judgments of quality, determined on a purely physical basis. This point has been discussed at some length in a previous publication[1] and will not be dwelt upon here further

[1] Stockberger, W. W. The Necessity for New Standards of Hop Valuation. Circular 33, Bureau of Plant Industry, U. S. Dept. of Agriculture. 1909.

than to state that it is well-nigh impossible to find two persons who will assign the same rank in value to six samples of commercial hops selected at random. Some light is thrown on these differences in judgment by a study of the different opinions rendered as to the relative value of the four lots of hops, all from the same source but subject to different conditions of treatment and storage. In order to bring out clearly some of the contrasts in these opinions, a table was prepared in which the physical and chemical valuations are compared. In this table the relative rank given each lot of hops by the four expert judges is indicated by the corresponding numeral.

The relative rank in acidity of the oils, which is similarly indicated, was determined from the results of the first analysis, since this analysis was made nearest in point of time to the physical valuations. The hops having the oils lowest in acidity were given the highest rank, those with oils next in acidity second rank, and so on, this order being determined by the fact that the hops having oils lowest in acidity had changed least from the original condition at the time of first storage. The relative rank with respect to ester content was determined in the same manner. The relative rank with respect to resins was determined from the content of soft resins, as these alone are considered to be the only resins of value in the utilization of hops. Since keeping quality, as indicated by a slow rate of change in the chemical constituents, is an important factor of value it was made the basis of relative rank in this case rather than the absolute quantity of soft resin. This relative keeping quality was determined from the difference in the content of soft resins, as shown by the two analyses. A direct comparison of all these relative rankings may be made from Table V.

TABLE V.—*Comparisons of rankings in value of sulphured and unsulphured hops in cold storage and in ordinary storage.*

Previous treatment of the hops.	Rank in value determined as noted.						
	By trade experts.				By acidity.	By ester content.	By keeping quality of soft resins.
	A.	B.	C.	D.			
Sulphured, cold stored	1	1	1	1	1	1	1
Unsulphured, cold stored	2	2	3	2	2	3	2
Sulphured, ordinary stored	3	4	2	4	3	2	4
Unsulphured, ordinary stored	4	3	4	3	4	4	3

From this table it appears that the rankings as to value are consistent in one case only, that of the sulphured cold-stored hops. However, on taking the judgments of the trade experts singly, that of expert A will be seen to agree with the rankings determined by

acidity, that of expert C with the rankings with respect to ester content, while the rankings of experts B and D agree with the order determined by the keeping quality of the soft resins. The reason for the differences in the judgments, based largely, if not entirely, upon the flavor or aroma of the hops, seems to lie, in part at least, in the difference of degree of sensitiveness of the individual to the several volatile constituents, which together form the aroma. It is well known that odors which are agreeable to some persons affect others unfavorably, and there is every reason to believe that in the present case the differences in judgment were due to the physiological idiosyncrasies of the observers. That this point of view is coming into wider recognition is shown by the following statement made by Dr. Albert Fischer:

> The determination of aroma is an entirely individual matter, depending upon the individual taste, the state of health, and the eventual influence of outside flavors on the person testing.[1]

However, since the number of individuals who passed judgment upon the experimental samples was small, the decisions rendered are not necessarily conclusive and certainly do not prove that the aroma should not be used as a factor in the determination of the value of hops. That the aroma is useful in determining the age and soundness of hops is conceded even by those who hold that it is not a proper factor from which to determine intrinsic value. The term "age" may be used to express the time that has elapsed since the hops were harvested or, in a relative sense, to denote the extent to which unfavorable changes have occurred in the hops. The hops under discussion here were of the same actual age, but owing to the different conditions of treatment they were of different relative ages, as shown by the different points to which the changes in the chemical constituents had progressed at the time of analysis. From the several classifications shown in Table V it is evident that the relative age and degree of deterioration as determined from analysis will depend very largely upon which one of the various constituents is selected as the basis of comparison. Similarly, the estimation of age or deterioration from the impressions produced by the aroma will vary according to the individual peculiarities of taste or fancy possessed by the observer. It is much to be regretted that there is not a better understanding of the relations between the factors commonly considered in establishing the relative market value of hops and the actual value of the hops in the processes in which they are utilized. The determination of a definite basis of value from which sound standards could be derived would have great practical importance, both for the producers and for the consumers of hops.

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[1] Fischer, A. Modern methods of hop analysis. Letters on Brewing, vol. 11, 1912, p. 317.

GENERAL SIGNIFICANCE OF THE RESULTS.

The material which furnished the basis for the observations discussed in this paper was prepared primarily with the view to determining the feasibility of abandoning the practice of sulphuring hops. Some previous experiments had shown [1] that under certain conditions there was some danger of hops becoming slightly contaminated with arsenic during the process of sulphuring, to obviate which the discontinuance of the use of sulphur was naturally suggested. It was expected that the unsulphured hops would be received with less favor by the trade than those which had been sulphured, owing to the more pronounced variations in the color of the former, but at the time the bales of hops selected for observation were placed in storage the difference in general appearance was comparatively small, although the sulphured hops could be readily distinguished by their more uniform and somewhat brighter color. A study of the trade opinions rendered on these hops after they had been for some time in storage apparently shows that the difference in appearance due to sulphuring becomes accentuated with age and that the preference is for the sulphured hop.

When freshly cured, the difference in color between sulphured and unsulphured hops is, as a rule, much more pronounced; and, however careful the grower might be to harvest his crop at the stage of maturity best calculated to give the greatest uniformity in color, it is evident that in marketing his product he would have to seek for those consumers who have a preference for the greenish grades of hops.

From the results of the chemical tests it is apparent that unsulphured hops are less suited to the requirements of the consumer than those that have been sulphured, especially when they are stored for a considerable length of time before they are used. However, the fact should not be lost sight of that these tests were made on hops which had been in storage for more than two years, and the changes observed are certainly considerably greater than those which occur in hops which have been stored for a shorter period. Nevertheless, the greater part of the changes in certain constituents takes place during the first year of storage, as has been shown by Heron [2] in the case of the tannin of hops. But from the work of Moser,[3] who found that the tannin content of unsulphured samples was consistently smaller than that of sulphured samples of the same sorts, it is evident that the oxidation of the tannin is retarded by sulphuring. It may

[1] Stockberger, W. W. The sources of arsenic in certain samples of dried hops. Bulletin 121, pt. 4, Bureau of Plant Industry, U. S. Dept. of Agriculture. 1908.

[2] Heron, John. The tannin of hops. Journal of the Federated Institutes of Brewing, vol. 2, 1896, p. 172.

[3] Cited by Braungart in Der Hopfen, Munich, 1901, p. 849.

be safely assumed, however, that sulphuring is an effective means of retarding chemical changes in hops from the time they are cured until they have reached the desirable limit of age, usually determined by commercial conditions, provided such hops are held in cold storage.

It is fully realized that the conclusions drawn in this paper are subject to the criticism that the analyses are too few in number and that they are not coordinate in point of time with each other and with the physical valuations. Certain obstacles encountered in the course of the work made it impossible to round out the results as fully as was desired, yet it is believed that the coordinations suggested by the facts developed are of sufficient importance to justify this somewhat incomplete presentation, which should be regarded more as a report of progress than as an attempt at a full elucidation of the problem, for which much further experimentation is necessary.

SUMMARY.

Material for a comparative study of the effects of cold and ordinary storage on sulphured and unsulphured hops was secured from a hop field in the Sacramento Valley, Cal. The green hops were divided into two lots, only one of which was sulphured during the process of drying. Bales from each lot were placed in cold and in ordinary storage, and samples from these bales were drawn from time to time for examination with respect to physical condition and certain chemical constituents.

At intervals of 7 and 18 months, respectively, from the time the hops were placed in storage, samples were drawn and submitted to trade experts, who were asked to rate the samples according to their relative quality. All agreed that the sulphured hops in cold storage were best in quality, but opinion was divided as to the relative merit of the three other lots.

Determinations were made of the acidity and ester content of the volatile oils extracted from samples of the hops under each condition of storage. The conclusions drawn from these analyses are that both sulphuring and cold storage retard changes in the hops leading to an increase in acidity and ester content of the oils. Cold storage is apparently more effective than sulphuring in retarding the increase in acidity, but is less efficient than sulphuring in retarding increase in ester content. Cold storage and sulphuring combined are much more effective in retarding changes in acidity and ester content than either alone.

The percentage of decrease in the content of soft resins was less in the cold-stored hops than in those in ordinary storage. The evidence from the analyses goes to show that the sulphuring tends to

retard changes in the content of soft resins only when combined with cold storage.

Trade experts to whom samples of the hops under consideration were submitted for physical judgment differed widely in their opinions of relative merit, except in the case of the sulphured cold-stored hops, which all agreed ranked first. The relative rank in merit as determined from each of the factors sought in analysis was found to give corresponding differences. A comparison of these differences in the physical and chemical valuations shows that the determination of the value of hops from the aroma depends upon the personal taste of the observer and is greatly affected by the individual's preference or dislike of one or the other of the several constituents of the aroma.

O

age about 1/2,500 of an inch in diameter, are spread out in a single layer in almost perfect contact with each other and are mixed so intimately and in such proportions that light passing through an unobscured plate appears white, or, more strictly speaking, a neutral gray.

For taking a photograph any ordinary camera may be used but a light orange color screen specially adapted to these plates must be fitted to the lens. The plates must be placed in their holders glass side toward the lens, instead of the reverse as in ordinary plates, so that during the exposure any light which reaches the sensitive film must first encounter the layer of starch grains, each grain of which will allow the passage of light of its own color and prevent the passage of light of any other color. Owing to the color screen and the still more retarding effect of the starch grains the plates are exceedingly slow and the exposures are from 75 to 100 times or more as long as would be required by the most rapid plates under the same conditions of light. After exposure the plate is developed in total darkness in a pyrogallic acid developer for about two and a half minutes, rinsed in water, and at once placed in a bath of permanganate of potash and sulphuric acid and carried from the darkroom into full daylight. The permanganate of potash and sulphuric acid mixture rapidly dissolves away the reduced silver in this negative but does not effect the unreduced portion. A second development in daylight, in paramidophenol, or a similar developer working without alkali, results in the reduction of the hitherto unchanged silver salt of the film and produces a positive in which the form and color of the object photographed are accurately reproduced. The colors, however, are generally weak and the plate must be intensified in order to bring them out in full brilliancy. The operations of clearing, fixing, drying and varnishing follow in rapid succession and the transparency is completed. As yet no method of making a colored print on paper has been perfected, but duplicate transparencies may be made by the ordinary methods.

As a means of easily and quickly producing colored photographs of many kinds of natural history objects this new process presents many advantages and in spite of the cost and shortcomings of the plates will doubtless come extensively into use. The exposure required, even under the most favorable conditions and with the most rapid lens, is so long that photographs of moving objects are out of the question. The plates are much less transparent than ordinary plates and when used as lantern slides require a stereopticon equipped with a powerful light and placed comparatively close to the screen. Added to these disadvantages is the much more serious one, that the colors of the starch granules, on which the color of the image depends, are not stable and gradually disappear if long subjected to the intense concentrated light of the oxyhydrogen or electric lantern.

The lantern slides exhibited covered a wide range of subjects, such as microphotographs of rock sections, various mineral and organic crystals with polarized light, direct photographs of the solar spectrum, copies of paintings, views of beetles, butterflies, shells, flowers, etc., and landscapes, demonstrating conclusively that it is now possible to photograph the color as well as the form of any object and fix them for future reference on a plate which, except under the most trying conditions of light, should last indefinitely.

The next communication, from Dr. F. V. Coville, was on "The Probable Assimilation of Free Nitrogen by the Swamp Blueberry (*Vaccinium corymbosum*)." An abstract on this subject will appear later.

The last communication, entitled "Some Problems and Possibilities in Hop Culture" was presented by Dr. W. W. Stockberger in the form of a lecture illustrated by lantern slides showing methods of cultivation, harvesting and curing the crop, and the comparative growth of local and European varieties on American soils.

Attention was directed to the desirability of selecting varieties adapted to the various conditions of soil and climate, to the influence of seasonal distribution of rainfall on growth and quality and to the necessity of a much broader knowledge of the physiological activi-

ties involved in the process of curing. A machine which promises soon to be available for picking the crop was mentioned as a possible solution of the labor question involved in harvesting.

The opportunity for the improvement of quality through selection and breeding was pointed out, the immediate problem therein being the discrimination of varieties which are now almost hopelessly confused. The work of breeding is further hampered by the fact that while more than a hundred varieties of the female form of the hop have been named only *one* variety of male plants is recognized.

M. C. Marsh,
Recording Secretary

THE GEOLOGICAL SOCIETY OF WASHINGTON

At the 198th meeting of the society, held at the Cosmos Club, on Wednesday evening, January 8, 1908, under informal communications, Mr. E. S. Bastin described a pyrrhotitic peridotite from East Union, Maine. This dike rock is unusual because of the presence in it of nearly 30 per cent. of pyrrhotite so related to fresh olivine and plagioclase grains that it is proved to be an original constituent. The analysis shows the rock to belong to subclass 2 of Class V. It is the first described representative of this subclass and has been named Lermondose. The total percentage of nickel, cobalt, and copper sulphides is about 2 per cent. It furnishes, therefore, an example of an ore of purely igneous origin.

Mr. R. H. Chapman exhibited photographs illustrating an ancient method of ore crushing near Gadug, about 300 miles southeast of Bombay, India. The bedrock with a gradual slope toward a stream has a shallow trench along the higher portion, from which water was fed over the surface, in which more than a hundred saucer-like depressions are located. These holes were used as mortars in which the ore was crushed by stone pestles in the hands of native laborers. Similar forms are known in which the mortars were larger and the crushers were boulders, of one half to one ton weight, which were handled with a framework. It is estimated that this quartz mill was in use about 2,000 years ago.

Regular Program

Centenary of the Geological Society of London: Mr. Whitman Cross.

Some Volcanoes of the Western Mediterranean: Henry S. Washington.

In the summer and fall of 1905 the speaker undertook the investigation of some of the less well-known volcanoes of the western basin of the Mediterranean for the Carnegie Institution of Washington. The volcanoes of Catalonia occupy the site of a Pliocene gulf, and are post-Quaternary. The earlier eruptions formed extensive and often deep lava flows, which partially filled the preexistent and still persistent drainage, and these were followed by the formation of numerous, small, cinder cones. The lavas are feldspar-basalts, nephelite-basalts, and limburgites, of quite uniform chemical characters.

The volcanic rocks of Sardinia are referred to three periods: a series of sheets of basalts and rhyolites, of Tertiary age, which cover extensive areas in western Sardinia; the subsequent large volcanoes of Monte Ferru and Monte Arci, near the west coast; and the numerous, small, recent, cinder cones which extend from near Bonorva to near Sassari. The lavas of Monte Ferru are trachytes and phonolites, which form the core of the deeply dissected volcano, and rather monotonous basalts, which cover the other lavas and extend far over the surrounding country. Similarly, the core of Monte Arci is composed of chemically uniform, though texturally diverse, rhyolites, covered by a mantle of later basalts. The recent cinder cones are wholly basaltic. Their eruption antedated the construction of the prehistoric nuraghi, for which Sardinia is famous.

The island of Pantelleria is wholly volcanic, the earliest eruptions being the trachytes of the dominating, but badly worn, Montagna Grande, with flows of other trachytic rocks. These were followed by flank eruptions of pantellerites, very high in silica and low in alumina, and distinctly sodic. The latest eruptions are basaltic and formed small cinder cones, like those of Catalonia and Sardinia,

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 121, PART IV.

B. T. GALLOWAY, *Chief of Bureau.*

THE SOURCES OF ARSENIC IN CERTAIN SAMPLES OF DRIED HOPS.

BY

W. W. STOCKBERGER,

Expert, Drug-Plant Investigations.

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THE SOURCES OF ARSENIC IN CERTAIN SAMPLES OF DRIED HOPS.[a]

By W. W. Stockberger, *Expert, Drug-Plant Investigations.*

INTRODUCTION.

For several years considerable attention has been given in England to the question of the origin of the arsenic sometimes found there in beer.[b] Some students of the question have pointed out glucose,[c] malt,[d] and hops[e] as possible sources of this substance. The occasional detection of minute quantities of arsenic in dried hops has furthered the belief that hops should be carefully examined for traces of this undesirable substance, a view which finds partial support in some experiments made with hops dried by each of the two processes used in England.[f] In one of these, known as the "direct" process, the hops are dried over open fires and are thus exposed to all the combustion products arising therefrom. In the other, or "indirect" process, a current of pure heated air is caused to pass through the

[a] The growing and curing of hops has been a subject of investigation in the Bureau of Plant Industry during the past two years by the office of Drug-Plant Investigations, under the direction of Dr. Rodney H. True, Physiologist in Charge. The execution of the work in both field and laboratory has been chiefly in the hands of Dr. W. W. Stockberger, Expert. In connection with these investigations, that phase concerning the occurrence of arsenic in hops has been touched upon with fruitful results, which are here summarized. Since the conclusions reached have an important bearing on matters of considerable economic importance, their immediate publication is deemed desirable.—B. T. Galloway, *Chief of Bureau.*

[b] Royal Commission on Arsenical Poisoning, London, 1901–1903. Report of the Medical Officer of Health for the City of London, No. 86.

[c] Windisch, W. Wochenschr. f. Brauerei, vol. 18, p. 30, 1901.—Hantke, E. Letters on Brewing, vol. 1, pp. 16–21, 1901.—Petermann, A. Ann. Sci. Agron., vol. 2, p. 396, 1901.

[d] Chapman, A. C. Analyst, vol. 26, p. 10, 1901.—Fairley, T. Analyst, vol. 26, p. 177, 1901; Pharm. Jour., vol. 65, pp. 634, 738, 1900.

[e] Baker, J. L., and Dick, W. D. Jour. Soc. Chem. Ind., vol. 23, p. 174, 1904.

[f] Duncan, C. County Analyst's Annual Report to the Worcestershire County Council, 1905, Appendix I, pp. 22–24.

hops, which do not come into direct contact with the gases or fumes from the fires. From the experiments cited the conclusion is drawn that hops dried by the indirect process are arsenic free.[a]

It is known, however, that traces of arsenic sometimes occur in hops which have been dried by the indirect process, a condition which has been urged in England as an argument against the purchase of imported hops, thus rendering more difficult the sale abroad of those grown in the United States.

Since under the ordinary conditions of hop production in the United States there is a surplus which requires an annual exportation of a considerable portion of the crop,[b] it is highly desirable that this product be prepared in every way free from deleterious substances which would interfere with its sale and use abroad.

During a recent study of the processes of curing and sulphuring hops[c] some experiments were made to determine the most probable source of arsenical contamination. The possible sources include fuels, arsenical sprays, the soil, and sulphur both when used in the field to destroy pests and when burned under the hops on the kiln during the drying process.

Since the open-fire, or "direct," process of drying is never used in this country, and as traces of arsenic have been found in hops not treated with insecticides, only the soil and sulphur were considered in these experiments, which, though not fully complete, have yielded results of so much importance to American hop growers that they are here presented in preliminary form.

ORIGIN OF SAMPLES OF HOPS EXAMINED.

The geographical distribution of hops containing traces of arsenic was first investigated. Dry commercial samples were obtained from England, Belgium, East Prussia (Altmark), Bavaria, Bohemia (Saaz), British Columbia, New York, Wisconsin, and the Pacific coast. Upon analysis[d] small quantities of arsenic (1.5 parts to the million, or less) were detected in samples from each of the regions just mentioned. These results indicate that hops from any of the hop-growing districts of the world may contain traces of arsenic, and suggest the necessity for the thorough examination of hops whatever

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[a] Duncan, C., loc. cit., p. 24.

[b] Merritt, E. Bul. 50, Bureau of Statistics, U. S. Dept. Agriculture, table 5, p. 13.

[c] Stockberger, W. W. Farmers' Bulletin No. 304, U. S. Dept. Agriculture, 1907, pp. 19–26.

[d] Except when otherwise stated all analyses for arsenic were made in the Bureau of Chemistry, United States Department of Agriculture.

their geographical origin, as well as the desirability of a careful scrutiny of the methods of cultivation and curing used abroad, particularly those processes in which, contrary to the American practice, hops are dried over open fires.

EXAMINATION OF HOP SOILS.

Samples of soil from a number of American hop fields have been examined for arsenic,[a] but in no case has its presence been detected. However, these results do not necessarily prove the absence of arsenic from the soils of the fields examined, since the hop plant has a very extensive and deep-growing root system which might very readily explore soil layers unrepresented in the samples taken.

Since traces of arsenic have been found in unsulphured hops grown on some of the soils from which these samples were taken, it may be inferred that the samples were not representative of the true soil conditions as just noted or that arsenic may be present in the soil in quantities too minute to be detected by the ordinary methods of analysis, the larger and measurable quantity in the plant being due to gradual accumulation during the process of growth.

THE ABSORPTION OF ARSENIC BY THE GROWING PLANT.

Some early authors held that living plants did not absorb arsenic,[b] but numerous plants have been found to contain this substance,[c] which was doubtless derived from the soil. Nobbe[d] states that only a very small quantity of arsenic is taken up by plants, though according to Angell[e] plants of rhubarb, bean, rye, and buckwheat accumulate appreciable quantities from soils heavily fertilized with superphosphates. Davy[f] found arsenic in peas, cabbages, and Swedish turnips grown in soils mixed with superphosphates, 40 per cent of which Lyttkins[g] states contain arsenic, in amounts varying from 0.012 to 0.26 per cent as estimated by Stoklasa.[h] Collins[i] found that barley

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[a] The analysis of the soil samples was made in the Bureau of Soils, United States Department of Agriculture.

[b] Targioni-Tazzetti, A. Ann. Sci. Nat., ser. 3, vol. 5, pp. 177–191, 1846.—Danberry, Chas. Quart. Jour. Chem. Soc., vol. 14, pp. 209–230, 1862.

[c] Pfeffer, W. Pflanzenphysiologie, 2 ed., vol. 1, pp. 432–433, 1897.

[d] Nobbe, F., Baessler, P., and Will, H. Landw. Versuchstat., vol. 30, p. 409, 1884.

[e] Angell, A. and A. F. Chem. and Drug., vol. 60, p. 430, 1902.

[f] Davy, E. W. Philos. Magazine, vol. 18, pp. 108–113, 1859.

[g] Lyttkins, A. Kgl. Landw. Akad. Handl., vol. 33, pp. 317–320, 1894.

[h] Stoklasa, J. Ztschr. Landw. Versuch. Oesterr., vol. 1, p. 154, 1898.

[i] Collins, S. H. Jour. Soc. Chem. Ind., vol. 21, pp. 222–223, 1902.

grown on soils containing arsenic may accumulate large amounts of this element, most of which, as has been further shown by pot experiments,[a] occurs in the barley grains. Likewise, Gosio [b] records the accumulation of arsenic in the leaves, stems, and fruits of squash plants which had been watered with dilute arsenic solutions.

In order to test the capability of the hop plant to take up arsenic from the soil, two adjoining plats of sixty hills each were selected in a hop yard and from May 24 to August 5, 1907, the alternate hills of one plat were watered weekly with solutions of arsenious acid and those of the other with solutions of arsenic acid. Each solution was made up in five different strengths, the arsenious acid ranging from 0.01 to 1 per cent and the arsenic acid from 1 to 3 per cent. Solutions of each acid were then applied to fifteen groups of two hills each in amounts so regulated as to form a gradually increasing series. In this way the total amount of arsenious acid administered to the plants of each hill ranged from one-tenth of an ounce to 24 ounces and the arsenic acid from 2 to 20 ounces to each hill. When the hops were mature, those from each group of two hills which had received the same treatment were gathered separately, dried without sulphur, and prepared for chemical examination.

Upon analysis traces of arsenic, from 0.5 to 3 parts per million, were found in each sample examined. While the amount of arsenic in various samples was not in direct proportion to the amount administered to the plant, the balance of evidence is in that direction. Necessarily the experimental error is very large, but when due allowance is made for it the results warrant the conclusion that hops will take up from soils containing available arsenic amounts relatively proportional to the quantity contained therein.

IMPURE SULPHUR AS A SOURCE OF ARSENIC.

That the sulphur used in sulphuring hops frequently contains small quantities of arsenic is quite generally known and has been suggested as the source of the arsenic occasionally found in dried hops.[c] However, analysis of the different grades of sulphur in common use indicates that from the quantities applied in most cases sufficient arsenic would not be produced to account for the traces sometimes found in hops, provided it was uniformly distributed through them. Analysis shows that there is often wide variation in the amount of arsenic contained in samples drawn from different bales

[a] County Councils Cumberland, etc. Tech. Education Rept., vol. 10, pp. 1–121, 125–150, 1901.

[b] Gosio, B. Atti r. Accad. Lincei, vol. 15, pp. 730–731, 1906; abstract in Centbl. Bak. Par. u. Infek., part 2, vol. 18, pp. 724–725, 1907.

[c] Rüffer, E. Wochenschr. f. Brauerei, vol. 18, p. 109, 1901.

of the same lot in which all the hops were grown and dried under practically the same conditions, and also in samples drawn from different portions of one and the same bale.

This apparent contradiction may be explained on the assumption that the arsenic volatilized by the burning of the sulphur is deposited on the layers of hops next the floor of the kiln while the upper layers remain practically free. To test this theory, a series of experiments was made with a small kiln in which different lots of hops were separately exposed to the fumes of equal amounts of the different grades of sulphur, after which samples were carefully taken from the top and bottom layers before the hops were removed. The experiment was repeated with double the quantity of each grade of sulphur used before. For comparison, a certain quantity of arsenious oxid was added to the sulphur, with which a final lot was treated.

The preliminary results of these experiments fully support the theory that arsenic may be transferred from sulphur to hops and unequally distributed therein. The analysis of the samples shows in practically every case a very appreciable difference between the amounts of arsenic deposited in the upper and lower layers of the hops. The evidence further indicates that the greater portion of the arsenic is deposited in the bottom layer. The variation in the results obtained with the different grades of sulphur was less than was anticipated, since each grade apparently increased materially the arsenic content of the hops.

Although each test was repeated, using double the amount of sulphur, the relative proportion of arsenic present was not constant. However, the results indicate that a larger arsenic content may be expected when the proportion of sulphur used is increased.

The samples from the last experiment, in which arsenious oxid (the white arsenic of commerce) was added to the sulphur, contained relatively large quantities of arsenic, twelve times as much being found in the hops of the bottom layer as in those of the top layer.

CONCLUSIONS.

From the foregoing experiments the following conclusions are drawn:

(1) Traces of arsenic may occasionally be found in dried hops irrespective of their geographical origin.

(2) If available arsenic is present in the soil it may be taken up by the hop plant under favorable conditions.

(3) Except in rare cases the amount of arsenic derived from the soil by the hop plant is probably smaller than 0.01 grain per pound of dry hops, which is the smallest amount regarded as deleterious by the Royal Commission on Arsenical Poisoning in England.

(4) By the use of impure sulphur during the process of curing, hops may be contaminated with arsenic, which will be concentrated in the lower layers on the kiln floor with the result that certain samples may show an amount greater than 0.01 grain per pound.

(5) The probability of hops acquiring arsenic from what seems to be a very ready source may be much lessened by employing only the very highest grades of purified sulphur in hop curing, and the quantity used should be reduced to the lowest possible limit.

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Dr J A LeClerc
with writer's regards

M. Schlesinger

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A STUDY OF INDIVIDUAL PERFORMANCE IN HOPS

W. W. Stockberger

Washington, D. C.

One of the problems of the breeder of plants or animals is to produce diversity or variations which may be made the foundation stock of new and improved strains; the corresponding problem of the practical grower is to secure uniformity, that is, to prevent or avoid those variations which tend to lessen the evenness or constancy of his product.

The normal diversity of the hop plant is so great that the breeder is put to little trouble in securing a wide range of variations suitable for his purpose. In fact, the variability of the plants in every field of hops is so great that, as was remarked to the writer by Dr. Fruwirth, of Vienna, there is really no necessity for hybridizing hops in order to secure material for the work of selection and improvement. The practical recognition of this fact is evidenced by the now universally adopted method of asexual propagation, by which the range of variability incident to seed propagation is materially diminished. Nevertheless many characters of a population of individuals produced asexually are subject to great variations which must be taken into account when the plants are considered from an economic standpoint. Some of these may well be mentioned specifically.

Variation in the characters of the vine.—The color of the vine may be green or red, green with red stripes, red with brown dots or whitish-green. In Europe three distinct varieties are based on the color of the vines but in America care has not been taken to observe these distinctions, and in many fields representative vines of each color may be found.

The number as well as the length of the internodes of the vine is also quite variable, ranging in normally developed individuals from 30 internodes, varying in length from 4 to 37 cm.; to 50 internodes,

varying in length from 3 to 34 cm. The average internodal length in the first case was 16.6 cm., in the second 23.5 cm.

In thickness the vine has been found to vary from 0.2 to 1.8 cm.

Variation in the flowering branches.—In some hop plants the strobiles occur singly in the axils of the stem leaves. Also they often occur singly at the nodes of the so-called arms, which are axes of the second degree. When the development is normal what may be termed flowering branches arise from the nodes of the arms, and these in turn may branch successively from one to five or six times. Variations of this class are of great economic importance since there is a direct relation between the degree of branching and the yield.

Variation in time of ripening.—The time of ripening of hops varies widely according to the variety, but in a population consisting of the same variety the range of variation in this respect is great. A very large proportion of the plants ripen at approximately the same time, but occasional individuals are found which are very early or unusually late in ripening. In one season the difference between these early and late ripening plants was found to be forty-two days.

Variation in the strobiles.—The form of the strobile varies from almost spherical or globular to long cylindrical, and all gradations between these regularly occur. The color varies from pale green through yellowish green to pale yellow. The number of bracteoles in normal strobiles has been found to vary from 14 to 53 mm., and the length of the rhachis or spindle from 18 to 42 mm.

Variation in relative proportions of vine, leaves and hops.—The weight of the vine alone has been observed to vary from 29 to 49 per cent of the weight of the whole plant, the weight of the leaves alone from 18 to 43 per cent, and the weight of the hops produced from 8 to 53 per cent.

Variation in yield.—A wide variation in yield will be found in any given population. The minimum record obtained by the writer in 1911 was 0.2 pound per hill, while the maximum was 25.5 pounds. The constants obtained as a result of three years observations are shown in the following table.

TABLE 1.—*Variation in yield, in pounds of hops on one acre.*

	Number of hills.	Mode.	Modal coefficient.	Mean.	Standard deviation.	Coefficient of variability.
1909	853	5.0	7.03	6.104+0.081	3.539±0.057	57.98±1.224
1910	865	6.0	7.63	5.839±0.062	2.714±0.043	46.48±0.851
1911	887	7.5	5.52	9.299±0.098	4.354±0.069	46.82±0.899

It will be observed that the highest standard deviation, 4.354 ± 0.069, occurred in 1911, which was a very favorable year for the growth and development of the hop plant, while the lowest standard deviation 2.714 ± 0.043, occurred in the previous year in which the plants under observation suffered severely from unfavorable weather conditions and attacks of insect pests. The coefficient of variability, however, for these two years differs by an amount which is less than the probable error. On the other hand the modal coefficient shows a higher degree of conformity to type in 1910 than in 1911.

Some comments may here be made on the usefulness of the coefficient of variability as an index of variation for the problem at hand, although it is realized that the data presented may be criticised since the number of individuals studied is small.

TABLE 2.—*Variation in yield, in pounds of hops according to the number of vines per hill.*

Vines to hill.	Number of hills.	Mode.	Modal coefficient.	Mean.	Standard deviation.	Coefficient of variability.
1	54	1	20.37	1.324±0.115	1.258±0.081	95.01±10.337
2	113	2	16.81	2.597±0.103	1.631±0.066	61.68± 3.672
3	135	5	13.33	4.337±0.132	2.275±0.093	51.99± 2.648
4	186	5	10.21	6.279±0.135	2.741±0.095	43.65± 2.159
5	188	7.5	9.52	7.917±0.158	3.217±0.111	40.63± 1.784
	....	and 8	9.52	....	....	....
6	168	11.0	8.33	8.991±0.152	2.931±0.107	32.59± 1.321
7	8	....	....	....	....	....
8	1	....	....	....	....	....

The plants on the acre on which these observation were made were handled in the manner customary in the production of this crop. Early in the spring all surplus shoots springing up from the crown of the plant are removed, the intent being to leave a definite number, usually 4, sometimes 6, to each hill. A count of the number of vines per hill on one acre at harvest time in 1909 showed, however, that the number varied from one to eight. The individual hills on this acre were then grouped according to the number of vines per hill and the constants for each group determined as shown in table 2.

An inspection of this table shows that the coefficient of variability diminishes progressively as the number of vines per hill increases, and the two apparently stand in a causal relation since the decrease in the coefficient of variability occurs because the mean which is dependent upon the number of vines increases much more rapidly than the standard deviation which undergoes relatively little change. Moreover the modal coefficient decreases as the number of vines per

hill increases, indicating that the type becomes *less conformable* as the degree of variability from the mean yield decreases.

Referring again to table 1 it will be seen however that this relation between modal coefficient and coefficient of variability does not obtain and hence may be assumed to have no significance. But in this case it will be observed that the modal coefficient diminishes as the standard deviation increases, also, with one exception this is true for the data of table 2. In the opinion of the writer this point is worthy of further consideration for an inspection of the frequency distributions for these three years shows that the number of classes in 1909 was 34, in 1910, 28, and in 1911, 42, while the highest frequencies for these years were 60, 66, and 49 respectively. The curve for 1911 is far less steep than that for 1910 and the mode also is less distinct since in a number of the classes the frequencies differ but slightly, although the number of extreme variates is about the same in each case. The effect of this less distinct mode is seen in the relatively large mean which in turn is responsible for the low coefficient of variability. If now we accept as the definition of variability "deviation from type" we must in this case at least consider the standard deviation as the index of variability rather than the usual coefficient. This interpretation, it is believed, is wholly consistent with the observed facts concerning variation in yield in the population studied.

It is not the writer's intention to minimize in any way the importance of the coefficient of variability, but rather to emphasize the fact that it is a measure of relative variation from the mean. However, for the population under consideration, which was fairly homogeneous and consisted very largely of the same individuals in each of the three years considered, it is the actual rather than the relative variation which is of primary importance, and when comparing the yield from year to year, the standard of deviation is certainly the better index of variability.

A consideration, also, of the sharp contrast in seasonal conditions in the years 1910 and 1911 in connection with the data already presented, furnishes additional support to the view that variation in a given population is far greater in a season favorable for the growth and development of the crop in question than in a season in which the conditions are less favorable.

Individual performance.—The data presented in the preceding paragraphs establishes the fact that there is great variation in yield among the plants studied, all of which were grown under conditions which were uniform for each year. It is also evident that each year some individuals gave much higher yields than others, but this knowledge

is of little value as an aid in selection unless the performance of each individual is known for a period of years. In order to secure such a record a plat was made of an acre of hops on which each hill was given a permanent number and the yield of each numbered hill has now been determined for three consecutive years. The constants for this data have not yet been calculated but the record of some of the extreme variants offers suggestions of value. The following tables show the yield of a few of these variants, the number of vines being constant for each hill during the entire period.

From table 3 it may be seen that there was a general depression in yield in the unfavorable season of 1910, although three hills gave a greater yield than in 1909 and two remained stationary. In 1911

TABLE 3.—*Three year record of hills lowest in yield in 1909.*

Hill number.	Yield in pounds.		
	1909.	1910.	1911.
17	5.0	2.5	13.0
61	2.0	1.5	0.5
174	7.5	4.0	6.5
297	6.5	6.0	6.5
319	5.5	11.5	16.5
332	7.5	7.0	17.0
377	7.5	7.5	15.5
474	4.0	7.5	8.0
550	6.0	3.5	6.0
643	7.5	3.5	8.0
669	6.0	5.5	15.0
702	6.5	6.5	5.0
887	7.0	9.0	10.0
893	7.0	5.5	12.0

nine hills gave an increased yield over 1909, two remained stationary and three were lower. Turning now to the high yielding hills of 1909, shown in table 4, it appears that here the yield in 1910 was depressed in all cases but one where it remained stationary.

In 1911 seven hills gave an increased yield over 1909, and five were lower in yield. Considering now the data of the two tables together and making due allowance for the unfavorable season in 1910, certain apparent tendencies may be thus expressed: in the given population the yield of some individuals tends to decrease from year to year, that of certain others tends to increase and that of still others remains approximately constant. This is not a generalization on the part of the writer but merely a suggestion as to certain variations in behavior of the plants studied which are worthy of more extended observation. It may be that these tendencies are due to the varying sensibility of

the plants to changed conditions as pointed out by Shull and by Love, or to a certain periodicity in yield such as has been observed in apples and other fruits, or to differences in the length of the life cycle of various individuals, some having been observed in the ascending phase, others in the descending phase.

It is evident that the most desirable individuals for commercial purposes are those which are least subject to variation and which most nearly maintain a level of performance with respect to yield. The selection for propagation of an individual giving a high yield in one year does not insure that it or its progeny will be in the same class in succeeding years. It also appears unwarranted to assume on the evidence of one or two years that a low yielding individual will necessarily continue low yielding and transmit the same tendency to its progeny.

TABLE 4.—*Three year record of hills highest in yield in 1909.*

Hill number.	Yield in pounds.		
	1909.	1910.	1911.
184	12.0	5.0	10.5
271	14.0	5.5	13.0
344	12.0	4.5	5.0
400	12.5	7.0	14.5
456	14.5	8.5	14.0
493	12.0	9.5	12.5
499	13.0	8.5	14.5
513	18.0	15.0	15.0
582	14.0	9.5	15.0
794	12.0	6.0	16.5
884	13.0	11.0	16.5
938	11.5	11.5	13.5

The logical course, therefore, seems to be to study the individual plant through a series of seasons until some reasonable forecast can be made as to the degree and direction of its variations. It should then be possible to choose plants for propagation which will be far more stable and profitable than thousands that are under cultivation today.

The problem of selection is further complicated by the necessity of taking into consideration along with the variations in yield the numerous other variations mentioned in the beginning of this paper. The writer's observations, therefore, from which the data given above has been selected, are planned to cover at least five years, and as much longer as circumstances shall permit, for it is believed that only through such a study of individual performance can the answer be found to certain questions of practical importance to every grower of hops.

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menge tritt sogleich oder innerhalb kurzer Zeit (2 bis 3 Minuten) eine grüngelbe, unter Umständen bis braunschwarze Färbung ein. Das im Wasser vorhandene Eisen wird hierbei in Ferrosulfid verwandelt, das in colloidaler Form gelöst bleibt. Bei geringen Eisenmengen im Wasser ist es ratsam, zum Vergleich stets den Versuch mit einem eisenfreien Wasser, am besten destilliertem, anzustellen oder aber auch das ursprüngliche nicht mit dem Reagens versetzte Wasser anzuwenden. Ich konnte auf diese Weise noch 0.15 Milligramm Fe im Liter nachweisen. Unter 0.5 Milligramm Fe war der Farbenton grünlich, darüber mehr grüngelb und bei noch mehr Eisen bräunlich bis braunschwarz. Bei einem Eisengehalt von 1 Milligramm Fe im Liter Wasser kann man die Grünfärbung schon in einem Reagensglase nach Verlauf von etwa zwei Minuten sehr schön beobachten. Auf Eisenoxydverbindungen reagiert jedoch Natriumsulfid weit weniger intensiv. Es beruht dies darauf, daß die Ferriverbindungen zu Ferroverbindungen reduziert werden unter Abspaltung von Schwefel, welcher in fein verteiltem Zustande durch seine weißliche Färbung stört:

$$Fe_2(OH)_6 + 3\ Na_2S = 2\ FeS + 6\ NaOH + S.$$

Zum Nachweise von Eisenoxydverbindungen kommt meiner Meinung nach am besten einzig und allein die bereits beschriebene Methode mit Kaliumrhodanid und Salzsäure in Betracht. Natriumsulfid als Reagens auf Eisenoxydulverbindungen ist auf meine Anregung hin bereits in verschiedenen Betrieben, Wasserwerken usw. mit günstigem Erfolg angewandt worden. Zur Ausgestaltung dieser Methode in eine quantitative, kolorimetrische Eisenbestimmung ist indessen Schwefelnatrium nicht besonders brauchbar. Hier ist jedenfalls der Kaliumrhodanidmethode mit Eisenoxydlösungen von genau bekanntem Gehalt der Vorzug zu geben. Abgesehen davon, daß aus dem überschüssigen Natriumsulfid in der Verdünnung durch den Luftzutritt eine allmähliche Schwefelausscheidung erfolgt, welche bei kolorimetrischen Arbeiten recht stört, kommt noch vor allen Dingen hinzu, daß Vergleichslösungen mit Ferrosalzen nicht haltbar sind. Selbst das durch seine Luftbeständigkeit gekennzeichnete Mohrsche Salz-Ferroammoniumsulfat ist in wässeriger Lösung ziemlich leicht oxydierbar. Sollten, was wohl nur sehr vereinzelt der Fall ist, noch andere Schwermetalle zugleich im Wasser vorhanden sein — in Frage kommt neben Kupfer hauptsächlich Blei —, so tritt hierbei ebenfalls durch Natriumsulfid die Färbung ein. Liegt eine solche Möglichkeit vor, so säuert man die gefärbte Flüssigkeit mit einigen Kubikzentimenter konzentrierter Salzsäure an. Ist nur Eisen vorhanden, so muß die Färbung verschwinden, da Ferrosulfid in verdünnter Salzsäure leicht löslich ist. Wird dagegen kein Unterschied wahrgenommen, so ist Blei bezw. Kupfer zugegen, bekanntlich Metalle, deren Sulfide in verdünnter Salzsäure nicht löslich sind.

Die Anwendung dieses Reagenses würde sich meines Erachtens auch bei Enteisenungsanlagen empfehlen, um schnell und sicher feststellen zu können, ob noch Eisenoxydul gelöst vorhanden ist und somit die Anlage genügend funktioniert. Beobachtet man bei einem künstlich enteisenten Wasser auf Zusatz von Schwefelnatrium unter den oben angegebenen Bedingungen in dem Schauzylinder keinen Farbenunterschied im Vergleich zu dem ursprünglichen, nicht mit Natriumsulfid beschickten Wasser, so kann man in der Regel annehmen, daß das betreffende Wasser für Trink- und Wirtschaftszwecke, sowie für die meisten technischen Betriebe genügend enteisent ist, da unter dieser Grenze 0.15 Milligramm Fe im Liter nur vereinzelt noch Unzuträglichkeiten, wie Verschlammung des Leitungsnetzes usw., erfolgen dürften. Zur Sicherheit wäre dann noch in obiger Weise auf Ferriverbindungen mit Rhodan zu prüfen. Ueber colloidal gelöstes Ferrioxyd, welches erfahrungsgemäß keine Eisenreaktion gibt, vergl. Ernst Schmidt Ausführliches Lehrbuch der pharmazeutischen Chemie, 5. Auflage, Braunschweig 1907, S. 836 ff. und L. Darapski, Das Gesetz der Eisenabscheidung aus Grundwässern, „Gesundheit" 1906, Nr. 13 und 14. Ueber das neuerdings von O. Lutz[1]) empfohlene Reagens (Protokatechosäure) auf Eisen vergleiche meine Ausführungen im „Journal für Gasbeleuchtung und Wasserversorgung", I, S. 898 ff. Für Nichtchemiker kommt meines Erachtens dieses Reagens nicht in Betracht.

Schlußsätze. Zum qualitativen Nachweise von Eisenoxydulverbindungen in der Menge, wie sie in der Regel in Grundwässern angetroffen wird, ist für die Praxis nach vorstehendem chemisch reines Natriumsulfid in zehnprozentiger wässeriger Lösung ein ausgezeichnetes, bequemes und zuverlässiges Mittel, das den übrigen hierfür bekannten Reagentien vorzuziehen ist. Empfindlichkeitsgrenze 0.15 Milligramm Eisen (Fe) im Liter Wasser. Zur Ausführung füllt man am besten das oben beschriebene Schaurohr von 30 Ztm. Höhe, 2 bis 2.5 Ztr. Lichtweite und ebenem Boden, dessen Seitenwände gegen Tageslicht geschützt werden können, mit dem zu prüfenden Wasser, fügt etwa 1 Kzm. Natriumsulfidlösung hinzu, mischt und beobachtet die etwa eintretende Färbung gegen einen weißen Hintergrund. Je nach dem Eisengehalt des betreffenden Wassers wird die Flüssigkeit hierbei grüngelb, grün bis schwarzbraun. In zweifelhaften Fällen, zumal bei sehr geringen Eisenmengen, ist ein Vergleich mit dem ursprünglichen, nicht mit dem Reagens beschickten Wasser anzustellen. Eventueller Verdacht auf Blei und Kupfer!

Für Eisenoxydsalze, welche aber in Grundwässern nur sehr vereinzelt vorkommen, ist der empfindlichste Nachweis mit Rhodankalium in salzsaurer Lösung. Empfindlichkeitsgrenze 0.05 Milligramm Eisen (Fe) im Liter Wasser. Zur Ausführung verfährt man in derselben Weise wie beim Nachweise der Oxydulverbindungen. Je nach der Eisenmenge ist hierbei der Farbenton von rosa bis blutrot. Die Ergebnisse der Eisenuntersuchung werden von den chemischen Laboratorien häufig in verschiedener Weise angegeben, teils als Eisenoxydul, teils als Eisenoxyd usw. Ueber die Verhältniszahlen genannter Verbindungen gibt die nachstehende Umrechnungstabelle Aufschluß:

Umrechnungstabelle.

		Eisen	Ferrooxyd	Ferrioxyd
1 Teil Eisen (Fe)	—	1.0	1.286	1.429
1 „ Ferrooxyd (Eisenoxydul, FeO)	=	0.778	1.0	1.11
1 „ Ferrioxyd (Eisenoxyd, Fe_2O_3)	—	0.7	0.9	1.0

[1]) „Chemiker-Zeitung", 1907, Nr. 45, S. 570.

Verbesserung der Qualität amerikanischen Hopfens.

Vortrag, gehalten in einer Versammlung des „American Institute of Brewing" in New-York am 20. Oktober 1907, von Dr. W. W. Stockberger im Vereinigte-Staaten-Agrikultur-Departement zu Washington.

Keiner der das Hervorbringen amerikanischer Kulturpflanzen behandelnden Fragen wird heute vielleicht mehr Aufmerksamkeit geschenkt als der Frage der Verbesserung besonderer Produkte. Die während der letzten zehn Jahre durch Beobachtung und Erfahrung gesammelten Tatsachen werden im Licht von durch Studium und Anwendung wissenschaftlicher Grundsätze erlangter Kenntnis betrachtet. Die Männer unserer Zeit erleben das Verschwinden des weitverbreiteten Glaubens, daß das Hervorbringen neuer und verbesserter Kulturpflanzenarten ein geheimnisvolles Verfahren und nur von denen durchzuführen sei, welche auf die Naturgesetze irgendeinen energischen Einfluß ausüben. Mit dem Schwinden dieses Glaubens kommt die Erkenntnis, daß die Naturgesetze, welche das Hervorbringen größerer, stärkerer und besserer Pflanzenarten bestimmen, obwohl noch sehr unvollkommen begriffen, durch das Eingreifen der Hände jedes sorgfältigen und nachdenkenden Landwirtes sehr erfolgreich geleitet werden können. Als Beispiel hierfür mögen die verbesserten Rassen fast aller Getreidearten, sowie der Futterpflanzen, Früchte und Gemüse angeführt sein, welche während der letzten Jahre gezogen worden sind. Diese Verbesserungen haben nach verschiedenen Richtungen hin stattgefunden; in einigen Rassen wurde Widerstand gegen Krankheiten, Kälte und Dürre entwickelt; in anderen feinere Qualität, angenehmerer Geschmack oder ein größerer Gehalt an wertvollen Bestandteilen. Es muß offen zugegeben werden, daß bei all diesem Fortschritt in der Verbesserung von Kulturpflanzen der Hopfen fast ganz vernachlässigt worden ist.

Und um das Wachsthum zu verlieren,
Müßt Ihr's täglich dreimal rühren.
Die Natur will ihre Rechte,
Denn es würd' die Pflanze grün,
Und des edlen Kornes Säfte
Bald der ganzen Frucht entziehn.
Doch wozu sollte dieses Grünen?
Brecht im Keime schon die Frucht;
Soll es nicht dem Manne ziemen,
Daß er bess're Früchte sucht?
Die Natur im Lauf zu hindern,
Hemmt er sie mit schneller Hand;
Nach dem höher'n Zweck zu zielen,
Gab ihm Gott ja den Verstand.
Gleicht es nicht dem ewigen Weben,
Was wir dunkel vor uns seh'n;
Muß nicht oft das Menschenleben
In Jünglingskraft schon untergeh'n?
Traurig sinkt sein Haupt darnieder,
Wie der Keim am Kerne stirbt;
Herrlicher ersteht er wieder,
Herrlich, wo er ewig wirkt.
Auf der Dörre-warme Zinnen
Bringet nun das Malz hinauf,
Treibt die Feuchtigkeit von hinnen
Durch der Wärme freien Lauf;
Seht, wie sich die Körner färben,
Nicht zu braun und nicht zu blaß
Muß der Saft die Farbe erben,
Hell wie Gold perl' es im Glas.
Reutert es dann fein und sauber,
Trennt den Keim vom Kerne fort;
Nimmer würden Biere lauter,
Bliebe beid's am selben Ort.
Eingesprengt mit wenig Wasser
    Mengt das Malz
    Mit Blitzesschnellen
    Takt auf Takt;
    Frisch Gesellen!
    Angepackt,
    Stich auf Stich,
    Auf und nieder,
    Schnell vermischt
    Drauf und drüber,
Daß die Kerne leise quellen;
Würden sonst die schönsten Theile
Nicht ein Spiel der Lüfte seyn?
Fortgesprüht mit Windeseile
Durch der Mühle schnellen Stein?
Brecht die dürre Frucht in Stücken,
Theilet sie mir siebenfach,
Daß des Wassers heiße Kraft
Sauge aus den edlen Saft.
Siedend braust es in der Pfanne,
Von der eingepreßten Flamme
Zischt es hoch zum Kessel raus.
    Schnell das Schrot herbei,
    Teigt es ein zum Brei;
    Doch erst kalt,
    Daß nicht zu bald
Und des Wassers heiße Kräfte
Gleich verbrüh'n die edlen Säfte.
Und nun schließt den Kreis, Gesellen,
Um den Bottich rund herum,
Meister muß sich oben stellen,
Die Arbeit kann beginnen nun.
Greift Ihr Knechte nach den Waffen,
Legt die Rinne an den Pfaffen,
Schöpft das Wasser aus der Pfanne,
Doch dämpft zuvor des Feuers Flamme.
Und ihr andern rascher Hand
Führt das Maischscheid wohlgewandt;
Gleich zusammen auf der Mitte,
Kommandirt mit ernstem Wort
Nach der Brauersprache Sitte,
Der Meister maischet tüchtig fort.
Ist das Wasser raus geschöpfet,
Habt Ihr alles gut vermischt,
Dann nehmt, was zu Boden setzet,
Siedet, daß es brausend zischt.
Schöpft die Masse wieder rüber
Nach drei viertel Stunden dann
Siedend in den Bottich wieder,
Und maischet tapfer Mann für Mann.
Abermals drei viertel Stunden
Laßt die zweite Dickmaisch kochen,
Arbeit't dann zum drittenmale,
Daß die Masse rauschend walle;
Schöpft ein'n Theil der Flüssigkeiten
Schnell hinein in leeren Kessel,
Daß die mächt'ge Kraft des Feuers
Nicht zersprenge seine Fessel.
Lasset dann mit rascher Hand
Die Lautermaisch hinab in Grand,
Hackt und pumpt sie in die Pfanne,
Bringt sie siedend durch die Flamme.
Und nun jetzt Ihr Knechte alle
Schließt zum viertenmal den Reih'n,
Daß wird nun zum letztenmale
Alles gut zusamm verein'n.
Bald nun werden wir vollenden
Das schwere Werk voll Müh' und Fleiß,
Doch den Segen wird uns spenden
Droben der für unsern Schweiß.
Gleich zusammen auf der Mitte
Führt das Maischscheid schnelle,
Daß es gleich der Fluthenwelle
Gegen sich einander rausche.
Laßt es brausen
    Rascher Hand,
    Wohlgewandt,
Daß jetzt der heißen Masse Kräfte
Der Frucht entziehen alle Säfte.
    Auf und fort!
    Ist des Meisters Wort.
Knechte, jetzt könnt Ihr Euch laben,
Habt genug Euch müssen plagen.
Doch der Meister bleibt zurücke,
Er betracht't mit ernstem Blicke
Seiner Arbeit mühsam Werk.
Mit des Thermometers Stärke
Prüft er forschend seine Werke,
Und find't Alles wohlgethan.

Obwohl er in der Reihe der Agrikulturprodukte der Vereinigten Staaten an 14. Stelle rangiert, sind die Versuche zur Verbesserung des Hopfens bisher nur vereinzelter Natur gewesen, oder sie wurden nur in so kleinem Maßstabe vorgenommen, daß sie industriell von geringem Werte waren. Es ist ein gewiß zu rechtfertigender Optimismus, welcher voraussagt, daß die Hopfenkultur so gute Aussichten für die Entwicklung und Verbesserung der Arten bietet, wie irgendeine andere Kulturpflanze.

Bei dem Versuche, die Hopfenpflanze zu verbessern, kommt als erste wichtige Frage die Aufstellung eines Vorbildes in Betracht — der Maßstab einer Qualität oder eines Wertes, nach dem der Landwirt sich bei seinen Verbesserungsbestrebungen zu richten hätte. Das Fehlen einer befriedigenden Qualitätsnorm verschuldet zum großen Teil die vorherrschenden lockeren und unbestimmten Ideen der Hopfenproduzenten in Bezug auf die charakteristischen Eigenschaften eines Hopfens bester Qualität. Die Normen, welche der Farmer sich aufgestellt hat, bildete er hauptsächlich nach den Anforderungen, welche der Händler, an den er verkaufte, an ihn stellte, oder auch nach den in seiner Umgegend herrschenden Ueberlieferungen. Bei der Bestimmung der Qualität marktfähigen Hopfens ist jeder Konsument sich selbst Gesetz gewesen mit dem häufigen Resultate, daß individuelle Vorzüge statt tatsächlichen Wertes die Wahl entscheiden. Und so kommt es denn, daß von einem Käufer zurückgewiesene Ware von einem anderen mit Begier gekauft wird, eine Sachlage, welche direkt dafür verantwortlich ist, daß die Hopfenproduzenten nach dem Motto handeln: „Einerlei, wie schlecht mein Hopfen ist, es findet sich schon jemand, der ihn kauft.“ Die Farmer haben sich auch mit Recht darüber beklagt, daß, wenn sie durch Extraarbeit und Unkosten sich bestreben, bessere Hopfenarten zu züchten, sie dafür doch nicht mehr Geld bekommen als der Mann, welcher mehr auf Quantität als auf Qualität achtet. Infolgedessen wechselt der Wert des Hopfens sehr häufig für den Konsumenten, und ebenso häufig ist die Durchschnittsqualität bedeutend unter der Norm der Vorzüglichkeit, welche erreicht werden könnte, wenn den praktischen Grundsätzen der Hopfenkultur, welche allen Hopfenproduzenten geläufig sein sollten, mehr Aufmerksamkeit geschenkt würde. Wenn der Produzent erst einmal weiß, daß man seinen Hopfen nach Normal-Bewertungsmethoden beurteilt, wird er sich bestreben, den Wert seines Produktes zu erhöhen. Ein hoffnungsvolles Zeichen ist es, daß unter den fortschrittlichen Hopfenproduzenten sich heute das Streben geltend macht, sich alles erreichbare Wissen bezüglich der besseren Hopfenkultur anzueignen und danach zu handeln. Sobald indessen der Farmer die Möglichkeit der Verbesserung der Hopfenpflanze eingesehen hat, sucht er auch nach genauen Normen zur Bewertung seines Produktes, nach einem Vorbild, welches den Anforderungen seiner Kunden entsprechen würde.

Die Frage eines gleichmäßigen Musters für die Hopfenbonitierung ist durchaus nicht neu, und sie bietet bekanntlich eine Reihe schwieriger und ungewöhnlicher Hindernisse. Tatsächlich scheint die auf physikalische Qualitäten allein gegründete Bonitierung systematisch von der durch den Chemiker vorgenommenen abzuweichen, sodaß in weiten Kreisen alle Versuche zur Aufstellung eines Schemas für die genaue Analyse oder Bestimmung des Wertes des Hopfens als vergeblich betrachtet werden. Trotzdem muß diese den Fortschritt des Landwirtes und des Technologen in erster Linie bedingende Frage, wenn auch nur versuchsweise, gelöst werden, denn unter den jetzigen Umständen ist es nicht immer leicht, die analytischen Resultate des einen Technologen mit denjenigen eines anderen zu vergleichen, und meistens ist es wirklich schwer, aus diesen Resultaten Schlüsse zu ziehen, nach denen der Landwirt sich richten könnte, um nicht erwünschte Eigenschaften seines Hopfens zu vermindern und wertvolle zu vermehren. Die ausgezeichneten Resultate, welche das Analysenkomitee der United States Brewers, Association erzielt hat, indem es zur Analysierung von Malz ein Schema aufstellte, sollte zur Lösung dieses Problems als Antrieb und Ermutigung dienen. Jedermann kennt die ernsten Hindernisse, welche dieses Komitee zu überwinden hatte, und wie wichtig seine Forschungen gewesen sind.

Es kann daher als ausgemachte Sache gelten, daß in ähnlicher W… Versuche zur Ausbildung und Annahme einer gleichmäßigen Meth… Bonitierung des Hopfens seitens der Society of Brewers' Chemists… United States, wie dieselbe in ihrer letzten Jahresversammlung beid… erfolgreich sein werden. Bei den Beratungen dieses Vereins wurde die… der Hopfenanalyse eingehend erörtert und ein fähiges Komitee erna… die Methoden der Hopfenanalyse und Bonitierung zu untersuchen u… Norm dafür festzustellen. Wenn dieses Komitee seine Arbeiten beend… berichtet hat, wird in der Entwicklung des Hopfenbaues ein … Schritt nach vorwärts getan sein, denn kein Faktor hat die Verbe… der Hopfenarten so sehr verzögert wie der Mangel an Einvern… über die Qualität und die Bestandteile des bestmöglichen Hopfen… bessere Verständnis bezüglich dieser Punkte seitens derjenigen, … am Hopfenbau ökonomisch interessiert sind, sollte den Weg zum … gleiche widersprechender Resultate der physikalischen und chemischen … suchungen bahnen und gleichzeitig die unbestimmten Begriffe des … über die Bestandteile klären, welche dem Hopfen seinen Brauwert … Wenn das erst einmal klar verstanden ist, wird es dem Farmer mögli… daran hinzuarbeiten, daß sein Hopfen die größtmögliche Menge … wünschenswerten Eigenschaften besitze. Dabei sollte man nicht überseh… die genaue Kenntnis des Verhältnisses der mineralischen Bestandteil… Qualität wahrscheinlich von großem Wert sein dürfte. Die Hopfenp… nimmt aus dem Boden zu ihrer Ernährung große Mengen wer… Bestandteile. Die wichtigsten derselben sind Kali und Phosphorsäure … aus der Zusammenstellung einer Anzahl Analysen von Hopfen … hervor, daß diese Pflanze dreimal soviel Kali und Phosphorsäure abso… als unsere gewöhnlichen Früchte und Nüsse, außer einer großen Qua… Stickstoff, woraus man schließen darf, daß durch an diesen Substanzen r… Dünger der Hopfenboden, welcher durch langanhaltende Bebauung unfruc… geworden ist, wieder ertragfähig gemacht werden könnte.

Hier nun wirft sich die Frage auf, ob ein löslicher Salzgehalt, der … Kochen des Hopfens ausgezogen wird, als wünschenswert erscheint. … Aroma des Tees wird bekanntlich durch die Natur und die Menge der in … zur Teebereitung dienenden Wasser enthaltenen Salze stark beeinflußt. W… scheinlich ist daher die Natur des Wassers wichtiger als die in dem Ho… enthaltene Salzmenge, wie die von Dr. Wyatt angeführten Fälle erken… lassen, wo kohlensauren Kalk und Magnesia enthaltendes Wasser benützt … zu viel Hopfenharz ausgezogen wurde, sodaß das Bier einen unangeneh… Geschmack bekam. Es ist auch nicht unmöglich, daß das Hopfenharz in u… verschiedenen Verhältnissen gebauten Hopfen in seiner Zusammensetzung … Löslichkeit schwankt und daraus die Unterschiede des Aromas und der schle… Geruch mancher unserer einheimischen Hopfenarten zu erklären wären.

Es sind vielfach Düngungsversuche gemacht worden, aber in … meisten Fällen wurde dabei fehlerhaft verfahren, denn man wollte nur d… Gewicht des Hopfens vermehren, nicht aber die Qualität verbessern. Trotzd… bietet diese Frage der Mineralbestandteile des Hopfens ein sehr weites F… der Beobachtung mit der Aussicht auf eventuelle Vermehrung der Quanti… und Qualität der wertvollen Bestandteile. Wir sollten auch von der R… welche Hopfenharz, die bitteren Substanzen und das flüchtige Oel … Hopfen spielen, nähere Kenntnis besitzen, um ihre Beziehungen zur Qualit… während des Trocknens fortwährend zu erwägen. Es wird allgemein anerkann… daß das sogenannte weiche Harz des Hopfens allein wertvoll sei, und doch ha… der Durchschnitts-Hopfenbauer davon keine Ahnung, denn er trocknet seinen Hopfe… oft bei solch hoher Temperatur, daß ein Teil des Oeles verflüchtigt und ei… beträchtliche Menge der wertvollen Hopfenharze oxydiert und in die harte, wertlo… Form umgewandelt wird. Bei einer kürzlich auf dem Felde vorgenommene… Reihe von Versuchen zeigte es sich, daß innerhalb gewisser Grenzen das Ver… hältnis des weichen zu dem harten Harze direkt von der Temperatur abhäng… bei welcher der Hopfen getrocknet wird, und somit ist hier eine Gelegenhe… zur sofortigen Verbesserung der Qualität des Hopfens, denn diese Harz…

Graue Adern sieht er schwimmen
Auf der Oberfläche Rand,
Sie bedeuten gute Zeichen;
Doch seinen Zweck auch zu erreichen,
Half er stets mit eigner Hand.
Laßt das Bier jetzt auf der Ruhe
Eine volle Stunde steh'n,
Daß die trüben Theile sinken;
Denn die Würze, sie muß blinken,
Schön, wie helles Gold, ausseh'n.
Schlagt sie dann hinein zur Pfanne,
Sprühen laßt die Flamme,
Schürt des Feuers Glut,
Daß der Elemente Wuth
Getrennt, und stets doch im Verein;
Und nun laßt die braunen Tropfen
Durch die edle Kraft des Hopfen
Dem Biere Wohlgeschmack verleih'n.
Hoch schäumt die Masse in dem Kessel
Und siedend wallet es und zischt;
Wohl möcht' die Flamme ihre Kessel
Zersprengen, daß es krachend bricht.
Frei wollen selbst die Elemente,
Verfolgen frei die freie Flur,
Sie wollen nicht durch uns're Hände
Gehindert seyn auf ihrer Spur;
Doch droben steht in seiner Größe
Der Mensch und lenkt mit Geisteskraft;
Er hemmt das wüthende Getöse,
Und staunt oft selbst vor ihrer Macht.
Und träumend versunken in tiefes Denken,
Schaut er betrachtend in sein Daseyn zurück,
Wie ein Gott ihn hieß, die Elemente zu lenken,
Zu schaffen und fördern sein eignes Glück.
Er ist's, den der Erhabene erkoren,
Er ist's, dem Alles hier anvertraut;
Er ward zum Glück, wie zum Unglück geboren,
Doch muthvoll er in die Ferne schaut.
Das Kind lebt hin bey tändelndem Spiele,
Es träumt nicht von Leiden, nicht von Lust,
Es schlummern in ihm noch alle Gefühle,
Beglückt ist es an der Mutter Brust.
Der Knabe entkeimt den Jugendtagen,
Es entfaltet sich schon der Erde Last,
Und um die Zahl der Leiden und der Klagen
Zu bekämpfen, fehlt ihm noch Kraft und Rast,
Da tritt er aus den Kinderjahren,
Und fröhlich wogt die heitre Brust,
Er lernt die Leiden und Gefahren
Erkennen und des Lebens Lust,
Voll glühender Jünglingskraft
Rollt ihm das Blut im Herzen,
Er fühlt ein Feuer angefacht,
Es glimmt wie helle Kerzen.
Es treibt ihn hinaus in's wogende Leben,
Zu wirken, zu schaffen mit emsigem Streben;
So eilt er hin auf der Bahn der Jugend,
Es hindert ihn nichts an seinem Thun,
Er blüht in der Unschuld schönster Tugend
Und sucht nicht zu rasten und nicht zu ruh'n.
Doch oft auf seinen Blüthenwegen
Trägt ihm ein neidisches Geschick
Die Dornenkrone herb entgegen,
Er strauchelt auf der Bahn des Glücks.
Was ist es, das ihn hier betrübet?
Ist es des Undanks herber Schmerz,
Daß oft alle, die er liebet,
Verkennen sein so gutes Herz?
Fehlt es ihm, daß er die Talente,
Die ihm ein Gott in's Herz erschuf,
Nicht fördern konnt', und seine Hände
Zum trägen Nichtsthun an sich trug?
O hadere nicht den schönsten Gaben,
Die oft ein edles Herz beglückt,
Sie werden tückisch untergraben
Und kommen nie ans Tageslicht;
Bau Du Dir selber Deine Welten —
Und lebe stille im Gefühl, —
Ein Gott, dort droben, wird's entgelten, —
Wir sind ja nicht des Zufalls Spiel.
Doch bist Du selig einst versunken,
Was uns des Lebens schönste Lust
Hier beut, daß Du liebetrunken
Verweilst an der Geliebten Brust,
Traulich dann am Arme Deiner Lieben
Herrlicher erscheint Dir dann die Flur,
Engeln gleich, mit ewig sanften Trieben
Rosen streut und bringt Dir die Natur.
Ewig dort und zeitlich hier beglücket,
Seligkeit die Lebensbahn umstricket
Eurer treuen Herzen ewig Seyn.
Haltet alsdann fest die schöne Beute,
Daß sie kein Dämon tückisch Euch entreißt,
Und lebet froh beglückt an ihrer Seite,
Bis einst von hier das irdische Daseyn fleucht.
Doch solltet dort Ihr auch betrogen
Euch finden, verjagt die Leidenschaft,
Die flammend einst die Brust durchwogen,
Als edles Opfer selbst gebracht.
Der Mensch kann straucheln, doch den Mann
Beugt nicht so leicht der trübe Schein,
Es wogt in ihm: Ich kann!
Des freyen Willens herrlich Seyn.
Ja reiß Dich los und denk mit Stolz,
Du bist ein Mann, der frei will seyn,
Der nicht um eines Mädchens Laune
Sich selbst zum ewigen Sklav will weih'n.
Denn unter tausend schönen Freuden
Trübt sich doch oft der Horizont,
Es ist kein Glück hier ohne Leiden,
Kein ewiges Glück auf Erden wohnt;
Und was der Süd und West will morden,
Das bietet treu auch noch der Ost,
Und kämst Du selbst zum fernen Norden,
Fänd dort Dein liebend Herz noch Trost.
Du höchstes Wesen dieser Zonen,
Es schuf ein Gott, der Dich hier schuf:
Du sollst die Welt als Mensch bewohnen,
Beherrschen Das, was sie Dir trug,
Du zügelst keck die Elemente,
Ertrotzt von ihnen ihre Kraft,
Hemmst durch die Werke Deiner Hände
Des Sturmes allgewalt'ge Macht

sind von größter Wichtigkeit, aber die Farmer werden erst dann die Menge des weichen Harzes zu vermehren suchen, wenn sie einsehen, daß ihre Konkurrenten, welche ihr Produkt sorgfältiger trocknen, höhere Preise erzielen. Es wird angenommen, daß die **flüchtigen Oele** im Hopfen dessen Aroma bedingen, aber ihre wirklichen Eigenschaften sind bis jetzt noch nicht gründlich untersucht worden. Die verschiedenen Hopfenarten schwanken in Bezug auf ihr Aroma, indessen kennt man vorläufig noch nicht die chemischen Verbindungen, welche diese Unterschiede herbeiführen. Da das flüchtige Oel eine Mischung von Verbindungen ist, beruhen die Verschiedenheiten im Aroma möglicherweise auf den schwankenden Verhältnissen, in welchen die Bestandteile der Oele gemischt sind. Was immer der technische Wert des Hopfenöles sein möge, das große Gewicht, welches bei der Bonitierung des Hopfens auf das Aroma gelegt wird, läßt vermuten, daß in der Zusammensetzung der Oele eine meßbare Charakteristik der Qualität gefunden werden könnte. Wenn die flüchtigen Oele der Hopfen aus verschiedenen Landesteilen, die wegen der Feinheit des Hopfenaromas berühmt sind, nachgewiesenermaßen in ihrer Zusammensetzung stets derart verschieden sind, daß daraus direkt eine Beziehung zur Verschiedenheit ihres Aromas hervorgeht, sollte man annehmen dürfen, daß die ausgesprochenen Verschiedenheiten wohlbegründet seien. Sollte aber eine sorgfältige Untersuchung dieser Oele keine nachweisbaren Verschiedenheiten oder Resultate ergeben, welche von den angenommenen Beziehungen zur Qualität abweichen, wird es vielleicht notwendig werden, unsere Ansichten über den Wert dieses Faktoren bei der Feststellung der Qualität des Hopfens gründlich zu ändern. Die große Menge Arbeit und die großen Ausgaben, welche ein gründliches Studium des Hopfenöles erfordern, hat die Chemiker wahrscheinlich bis jetzt von diesem Studium abgehalten. Einige Vorarbeiten in dieser Richtung haben indessen vielversprechende Resultate gezeitigt, und deshalb ist eine gründliche Untersuchung der Beziehungen des flüchtigen Oeles zur Qualität des Hopfens aus verschiedenen Produktionsgebieten geplant und in Angriff genommen worden. Mit vermehrter Kenntnis der Bestandteile des Hopfens ist dem Studium der Faktoren, welche der Bildung und Natur dieser Produkte Vorschub leisten, ein weites Gebiet eröffnet worden. Ueber den Einfluß des Bodens, klimatischer Verhältnisse, des Düngers, der Bewässerung oder Eigenart auf das Oel, die Harze, Bitterstoffe und das Tannin des Hopfens ist verhältnismäßig wenig bekannt. Und deshalb sollte man denselben eingehend studieren, weil hierdurch vielleicht wissenschaftlich und praktisch sehr wertvolle Resultate erzielt werden dürften. Wenn wir dem Farmer sagen können, daß eine gewisse Hopfenart eine bessere Qualität Bitterstoffe oder Harze enthält als eine andere, oder daß ein gewisser Dünger oder eine gewisse Zuchtmethode diese Bestandteile vermehrt und somit den Wert seines Hopfens erhöht, werden wir sichre und wirkliche weitere Gründe haben, auf welche hin besserer Hopfen gebaut werden kann.

Das **Vorhandensein von Läusen und Pilzen im Hopfen** ist für den Konsumenten eine stete Gefahr, und dem Farmer wird dadurch großer Schaden zugefügt. Noch vor wenigen Jahren waren diese Feinde in einigen Hopfenbaugebieten unbekannt, aber sie haben sich schnell verbreitet und sind jetzt überall zu finden. In Kalifornien, welches zuletzt von den Feinden des Hopfens angegriffen wurde, ist der Hopfenbau von ihnen ernstlich bedroht, und die Verluste steigen von Jahr zu Jahr. Selbstverständlich werden alle Mittel zur Ausrottung dieser Feinde allen Interessenten hoch willkommen sein. Seit einiger Zeit ist versucht worden, Pflanzen zu züchten, welche den Angriffen von Parasiten und Pilzkrankheiten widerstehen. Man hat Pflanzenarten und verschiedene Individuen ein und derselben Art gefunden, welche den Angriffen dieser Feinde mehr oder weniger erfolgreichen Widerstand leisten, und aus der Analogie vieler Fälle unter den Kulturpflanzen werden wir wohl gewisse Individuen entdecken können, welche ihre Widerstandskraft auch auf ihre Nachfolger vererben und daher eine ergiebige Ernte garantieren. Während der vergangenen Saison wurden im Staate New-York, welcher von Pilzkrankheiten arg infiziert ist, Stellen gefunden, auf denen nur völlig gesunder Hopfen wuchs, während in der ganzen Umgebung die Pflanzen erkrankt waren. Von den gesunden Hopfenformen werden im nächsten Frühling Stecklinge zur Fortpflanzung der gesunden Arten genommen werden, und da dieses Werk in dem Streben nach Verbesserung der Hopfenarten von größter Wichtigkeit ist, arbeitet man jetzt an Plänen für seine allgemeine Ausdehnung.

Das Prinzip der **Zuchtwahl** kann zu vielen anderen Zwecken als Erzeugung von Pflanzen, welche Krankheiten widerstehen, angewendet werden. Man kann damit die Qualität und Ertragsfähigkeit der Hopfenpflanze verbessern und vermehren. Auf jeder Hopfenfarm finden sich Pflanzen, die besser tragen, als andere. Diese verwendet man zur Zucht, und auf solche Weise erlangt man ganze Farmen, die ertragsfähiger sind als andere. Von Zeit zu Zeit findet man Hopfenpflanzen, welche vom Durchschnitt außerordentlich abweichen, sowohl in Bezug auf die Zeit der Reife wie der Farbe, den Ertrag und andere Eigenschaften, und dieselben auf ihre Nachkommen vererben. In gewissen Fällen werden geringe Abweichungen durch Zufall in der Umgebung bedingt, aber große, bedeutende Unterschiede, welche beständig und vererbbar sind, müssen auf Verschiedenheiten der Struktur beruhen, und mehreren unserer Hopfenarten wird ein derartiger Ursprung zugeschrieben. Obwohl die Geschichte ihrer Abstammung von manchen angezweifelt wird, sind gute Gründe zur Annahme vorhanden, daß bekannte Arten, wie die Early Brambling, Golding, Humphrey und Smith-Hopfen, auf diese Weise entstanden sind. Von diesen ist der Humphrey Hopfen amerikanischen Ursprungs, und nach einer Tradition in Wisconsin, von wo er zuerst verbreitet wurde, brachte die Frau eines deutschen Ansiedlers im Nordwesten die Wurzel einer Hopfenpflanze aus Deutschland mit, aus welcher dann der Humphrey entstand. Nach einer anderen Auslegung war ein Setzling aus einer hiesigen Farm die erste Hopfenpflanze dieser Art. Abgesehen von ihrem Ursprung, ist diese Art dem Produzenten wertvoll, weil sie früh reift, äußerst kräftig ist und in gewissen Gebieten Läusen und Pilzen Widerstand leistet. Dies ist nur ein Beispiel für das plötzliche Entstehen besserer Arten, die glücklicherweise entdeckt und fortgepflanzt wurden. Fast jedes Jahr findet man solche neuen Arten fast auf jeder Hopfenfarm. Wahrscheinlich sind die meisten von ihnen nur wenig verschiedene Abarten und bleiben daher unbeachtet. Andererseits wird aber auch die Wichtigkeit dieser Abarten von den Farmern eingesehen. Vor einigen Jahren entdeckte **C. H. Curtis** von Waterville, N. Y., eine solche neue Art, und er macht jetzt auf seinen Besitzungen damit Versuche. Die Propaganda für die Zuchtwahl zur Erlangung besserer Hopfenarten kann nicht durch akademische Belehrung in landwirtschaftlichen Fachblättern noch durch andere Literatur, welche man unter den Farmern verbreitet, betrieben werden, sondern man muß ihnen die Sache durch praktische Anwendung auf ihren eigenen Farmen vorführen, und dann wird die gesamte Industrie davon Vorteil haben.

Selbstverständlich muß man bei der Zuchtwahl besserer Individuen die Wichtigkeit der Züchtung reiner Rassen im Auge behalten. Die kürzlich erfolgte Veröffentlichung der Methode von Dr. **Nilson** und seiner vorzüglichen Resultate in der Züchtung neuer Getreiderassen hat der Bewegung zur Hervorbringung besserer und reinerer Rassen von Kulturpflanzen in den Vereinigten Staaten bedeutenden Vorschub geleistet. Infolge gewisser natürlicher Charaktereigenschaften eignet sich der Hopfen ganz besonders zu Zuchtzwecken. Die männlichen und weiblichen Blüten werden von getrennten Individuen getragen, und nur die weiblichen bilden den Hopfen des Handels. Den Blütenstaub des männlichen Hopfens tragen Wind oder Insekten umher, und an Orten, wo weiblicher neben dem männlichen Hopfen wächst, bilden sich Bastardpflanzen, deren Samen Pflanzen erzeugt, welche von den Eltern derart verschieden sind, daß der Farmer nur in den seltensten Fällen seine Hopfenpflanzen aus Samen zieht. Auch sind die aus Samen gezogenen Pflanzen meist zur Hälfte weibliche und zur anderen Hälfte männliche Exemplare, auch brauchen sie zu ihrer vollen Entwicklung drei Jahre. Deshalb zieht man den Hopfen größtenteils aus Wurzelstöcklingen, welche stabilere und gleichmäßigere Pflanzen liefern und die charakteristischen Eigenschaften der Mutterpflanze unverändert beibehalten. Die großen Verschiedenheiten in den aus dem Samen einer be-

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Die Fluth bricht sich an Deinen Dämmen,
Der Erde zwingst Du Segen ab,
Die Flammenwuth im Lauf zu zähmen,
Blickst Du mit ernstem Stolz hinab,
Erkennest Gott und seine Werke,
Bekämpfest siegend die Natur, —
Und solltest nicht des Willens Stärke
Frei bändigen auf ihrer Spur?
Da wallet es, die Fluthen strecken
Sich brausend aus des Kessels Raum,
Sie wollen freundlich ihn erwecken,
Verscheuchen der Gedanken Traum.
Des Hopfens Kräfte sind entschwunden,
Dem Biere ist der Saft verlieh'n,
Mit seinem Aroma verbunden
Soll Euch der edle Trank erglüh'n.
Dämpft die Flamme,
Rasch hinaus zur Pfanne
Schlagt die heiße Masse,
Daß auf der Kühle breiten Flächen
Die Wärmegrade sich nun brechen.
Bald wird Alles schön sich enden,
Der Mensch, er hat sein Werk gethan,
Die Natur mag nun vollenden
Was er schuf mit Kraft als Mann.
In des Kellers Räumen
Laßt das Bier in Bottich' h'nab,
Zieht die Würze, daß es schäumet,
Mit dem Zeuge gut vereinet,
Kann die Gährung vor sich geh'n.
Und nun lasset alles stehen,
Die Natur beginnt ihr Werk;
Was die Erde uns gegeben,
Schufen treu wir in das Leben
Mit des Wassers Saft
Und des Feuers Kraft.
Möge nun die Atmosphäre
Günstig seyn, daß Alles gähre.
Hoch steigen
Die Kreisen
Zum Bottich heraus.

Der Kohlensäure geistige Luft
Verbreitet sich mit aromatischem Duft.
Die Fermentation
Geht langsam von statten.
Ein Theil der Zuckerstoffes Kräfte
Verwandeln sich in Weingeists Säfte.
Dann senken sich die trüben Theile,
Die vermengt erst schwammen oben,
Mit der Colla eng vereinet
Hin zur Tiefe auf den Boden.
Die Gährung wird nun gleich vollenden,
Jetzt können wir die Arbeit enden.
Herein, herein
Ihr Knechte, schließt den Reihn!
Reif ist nun das Bier zum Fassen,
Länger dürfen wir nicht passen;
Schwingt die Schaffel
Um die Wette,
In der Reihe langer Kette
Laßt ihn wandern
Von dem einen zu dem andern,
Und stimmet zur Arbeit heitern Gang
Einen fröhlichen herzlichen Brangesang.
(Der Gesang der Brauknechte.)
Fröhlich und mit emsigem Streben,
Ohne Sorgen, ohne Harm,
Wandeln wir so froh durchs Leben
Mit dem Maßkrug unterm Arm;
Drum laßet uns munter die Arbeit vollbringen
Und unserm Meister ein Loblied singen.
Hoch leb Er, der König von Brabant,
Der den edlen Saft einst selbst erfand.
Wenn Andre noch im Schlummer liegen,
Dann schwitzen wir schon, daß es kracht,
Daß oft sich unsre Knochen biegen,
Doch ist nichts, was uns mürrisch macht;
Denn es lächelt so mild wie die Sterne
Der Maßkrug uns winkend aus der Ferne.
Rasch schlürfen wir runter den edlen Saft,
Er gibt den ermüdeten Gliedern Kraft.
Hoch sollen alle Brauer leben,

Stoßt tapfer mit den Gläsern an;
Du Maßkrug, sei uns treu ergeben,
Du stärkst den Muth, Du machst den Mann.
Du bist es, der den Müden, den Kranken erquickest,
Den Launigen, den Verliebten zum Gotte beglückest.
Hoch leb er, der Meister von Brabant!
Hoch lebe das schöne Bayerland!
Und strecken wir die ermatteten Glieder,
Wenn die Gurgel nicht mehr zu trinken verlangt,
Auf dem Brette der Bahre der Länge nach nieder,
Dann nur noch ein volles Glas in die Hand,
Damit wollen wir den Tod freundlich begrüßen,
Und willig ihn in die Arme schließen,
Führ er uns dann hin zum bessern Seyn
In die Pforte der ewigen Heimath hinein,
Den Maßkrug auf des Grabes Hügel,
Den setzt Euch dann als Leichenstein;
Er sei der Welt zum ewigen Spiegel,
Und grabet diese Grabschrift ein:
„Lächle, o Wanderer, mit freundlichen Blicken,
Den Bierheld muß hier sein Heiligthum schmücken,
Er hat ihn begleitet mit Treue durch's Leben,
Drum ist er im Tode ihm treu noch ergeben!"
Reibt den Wechsel zu,
Jetzt hat alles Ruh.
Die Arbeit hat jetzt nun ein Ende,
Bis die Lagerzeit vollende;
Und nun zapfet an das Faß,
Schäumend füllt das Glas.
Weiß wie Schnee muß es moussiren,
Bald werd't Ihr die Kräfte spüren.
Seht, wie hell und klar es schimmert,
Helle, wie der Sonne Gold;
Ernten wir für uns're Mühe
Nun des Dankes schönsten Sold;
So haben wir denn nun erschaffen
Den edlen Trank für Reich' und Arm.
O mögen alle sich dran laben
Und möge er die Wirkung haben,
Verscheuchen Kummer, Sorg und Harm;
Den Müden möge er erquicken,

stimmter Art gezüchtetem Hopfen deutet an, daß die neuen Arten eine Mischung vieler elementarer und verschiedener Typen bilden, welche in ihren botanischen Merkmalen und ökonomischen Eigenschaften verschieden sind. Wenn diese Typen ausgewählt und fortgepflanzt werden, bleiben sie konstant und bilden neue und reine Rassen. Der aus Samen gezogene Hopfen vereinigt die Eigenschaften seiner weiblichen und männlichen Vorfahren, von welchen einige vorherrschen und der Pflanze ihre besonderen Merkmale geben. Andere elterliche Eigenschaften sind latent oder rückbildend und lassen dies an der Samenpflanze nicht ersehen, treten aber später in einem Teil ihrer Nachkommen auf. Diesen Beobachtungen liegt die Methode zur Züchtung reiner Rassen zugrunde, welche aus einem einzigen Samenkorn entstanden, und bei denen durch sorgfältige Auswahl während einer Reihe von Jahren alle Individuen, welche die elterlichen Eigenschaften nicht beibehalten, ausgemerzt und zerstört wurden. Wenn erst einmal eine reine Rasse erzeugt ist, läßt sie sich leicht fortpflanzen. Durch Mendels Entdeckung und die glänzenden Versuche von de Vries haben wir die Naturgesetze bezüglich der Variationen der Pflanzen einigermaßen verstehen gelernt, und ihre Anwendung gewinnt von Jahr zu Jahr an Wichtigkeit und Wert für die Landwirtschaft. Der Erzeugung neuer Rassen durch Kreuzung und den Möglichkeiten der Verbesserung beginnt man den Wert beizulegen, welchen sie verdienen. Man kann auf diese Weise Pflanzen erzeugen, welche in sich die wertvollen Eigenschaften von zwei oder mehr Individuen vereinigen. Es gibt daher keinen Grund, weshalb im Hopfen die Eigenschaft feinen Aromas nicht mit reichem Ertrag, Frühreife mit großem Inhalt an Hopfenharz oder milde Bitterstoffe, guter Geschmack und Ausbeute mit Widerstand gegen Krankheiten vereinigt werden sollten. Einige Eigenschaften sind rein morphologisch, wie Wachstum, Ausbeute, Größe der Dolden usw., während andere, welche sich auf das Oel, die Harze, Bitterstoffe usw. beziehen, mehr als chemisch zu betrachten sind. Zweifellos wird es erfolglos sein, eine Pflanze zu züchten, welche alle diese Eigenschaften im höchsten Grade vereinigt, aber die wertvollsten Rassen, welche Burbank gezüchtet hat, vereinigen durch wiederholte Bastardzüchtung die besten Eigenschaften einer Anzahl ausgewählter Vorfahren in sich. Viele andere Forscher haben gefunden, daß Bastarde ihren Eltern häufig an guten Eigenschaften überlegen sind.

Versuche mit Zerealien und anderen Agrikulturprodukten haben dargetan, daß manche Arten sich gewissen Gegenden besser anpassen als andere, und deshalb sollte man sorgfältig studieren, wie sich die hauptsächlichsten Hopfenarten in Bezug auf Klima, Boden und Kultur in den verschiedenen Hopfengegenden verhalten. Die Arten schwanken nicht nur in ihrer Anpassungsfähigkeit, sondern ihre Abarten zeigen darin große Verschiedenheiten. Durch Versetzen einer Art in einen anderen Boden entstehen häufig derartige Veränderungen, daß die neuen Arten von ihren Mutterpflanzen völlig abweichen und mit ihnen kaum mehr Aehnlichkeit haben. Die charakteristische Reifezeit und Ausbeute bleiben jedoch unverändert, was darauf hindeutet, daß diese Eigenschaften erblich sind, und daß diejenigen, welche in der neuen Umgebung verändert wurden, dies jedenfalls nur der letzteren verdanken, und daß sie sich nach den jedesmaligen Bedingungen ihrer Umgebung richten. Wenn eine Pflanze während einer Reihe von Jahren unter beständigen Bedingungen kultiviert worden ist, gewöhnt sie sich daran, und man kann wohl nur ganz geringe Abweichungen erwarten; aber Abweichungen, die mehr oder weniger unerwünscht sind, erfolgen sicher beim Anbau unter durchaus verschiedenen Bedingungen. Der Wechsel kann der Pflanze sogar gefährlich werden, und sie kann an Lebenskraft und Ertragsfähigkeit verlieren. Daß diese Faktoren beim Hopfenbau nicht beachtet worden sind, geht deutlich aus der Praxis des Verteilens der Setzlinge ohne Rücksicht auf ihre Abstammung, Wachstumsbedingungen und neue Umgebung hervor, welche die Entwicklung starker und lebensfähiger Pflanzen erforde… Deshalb erscheint es unpraktisch, unseren einheimischen Hopfen durch E… führung von Setzlingen aus anderen Ländern, ausgenommen zum Zwecke … Züchtung neuer Rassen durch Kreuzung, verbessern zu wollen, und die tunlich… Methode ist daher die Züchtung neuer, verbesserter einheimischer Ras… Viele unserer gewöhnlichen Früchte, Gemüse und Getreide sind ausländis… Ursprunges, aber infolge der Anpassung an neue Umgebung oder das E… stehen neuer Arten durch Samenpflanzen vom ursprünglichen Stamm ist … Zahl unserer jetzigen Arten sehr groß. Bei dem Versuch, unseren einheimi… Hopfen zu verbessern, sollte man sich der Vorteile bedienen, welche die la… Erfahrung bei der Verbesserung anderer Produkte und die daraus abgeleite… Prinzipien uns darbieten.

Es ist schon erwähnt worden, daß es sich für Privatleute kaum lohn… Verbesserung des Hopfens durch Kreuzen anzustreben. Gerade weil … Bestrebungen bis jetzt fast nur Privatleuten überlassen wurden, ist in der … besserung des Hopfens so wenig geleistet worden. Aber die Sache ist so wich… daß man sie nicht länger den Privatleuten überlassen sollte, denn die allgeme… ökonomischen Interessen verlangen schnellere Fortschritte der Hopfenkultur, … sie von Privaten herbeigeführt werden können. Vereine und Organisatio… deren Geschäftsinteressen mit der Hopfenkultur zusammenhängen, sollte… an diesem Werke beteiligen. Die Hilfsquellen des Staates sollten herangezo… und diejenigen der Versuchsstationen und landwirtschaftlichen Lehranstalten … ihrem vollen Umfange ausgenützt werden. Um die Stellung der Bun… regierung diesbezüglich zu kennzeichnen und eine Vorstellung von demjen… Teil der Arbeit, welchen sie am besten übernehmen könnte, zu geben, mögen h… folgende Ausführungen aus einem kürzlich gehaltenen Vortrage des H… Agrikultursekretärs W. M. Hays angeführt werden:

„Das Bundes-Departement für Agrikultur kann bei Vornahme n… wendiger theoretischer Untersuchungen der allgemeinen Tatsachen und … Theorie der Vererbung und der Züchtung von Pflanzen und Tieren … Führung übernehmen. Es kann auch den Forschungsstationen, Verein… Firmen und Privatleuten, welche sich mit der Züchtung besserer Rass… abgeben, behilflich sein. Kurz, es kann mehr und mehr eine große A… klärungsstätte werden, durch welche die verschiedenen Gruppen und Agentur… miteinander Hand in Hand gehen. Es kann Unternehmungen, welche au… gedehnte und wirksame Arbeit leisten, dadurch beistehen, das es durch Bunde… mittel die Pläne ausführt, welche von Angestellten des Zentraldepartemen… oder anderen erdacht und vorgeschlagen werden. Es kann der Mittelpunkt fü… allgemeine Auskunft, allgemein hilfreiche Verwaltung und fruchtbare Arbe… werden. Das Feld ist so ausgedehnt, daß alle verfügbaren Hilfsorgane unter… stützt, aufgebaut, gefördert und, jedes auf seinem besonderen Felde, entwickel… werden sollten."

Somit ist nun die Gelegenheit zur Verbesserung unseres einheimische… Hopfens angedeutet worden, indem man ihn bei niedrigeren Temperaturen trocknet, die Natur und Bedingungen der Harzbildung studiert, widerstandsfähige Rassen züchtet und die besten und fruchtbarsten Typen zur Zuchtwahl für reine Rassen aussucht. Der Grund ist für diesen Zweck bereits vorläufig gelockert, Pläne sind entworfen und Grundsteine gelegt. Der in der Zukunft liegende Ausbau und seine Entwicklung werden von den Summen abhängen, welche zur Vollendung des Werkes erforderlich sind, sowie von der Mitwirkung und Unterstützung seitens derjenigen, welche durch das Werk eine Förderung ihrer eigenen Interessen erwarten können.

~ ~

Den Kranken Stärkung stets verleih'n,
Und alle Menschen froh beglücken
Im friedlich innigen Verein.
Im Zirkel der Zecher
Laßt kreisen die Becher.
Und seit ihr brav durstig,
Dann lab' Euch der Saft,
Seid munter und lustig,
Er mehre die Kraft;
Und scheidet von hinnen
Mit fröhlichen Sinnen,
Bis freundlich Aurora von neuem wird winken,
Zu laden Euch ein, von vorne zu trinken.
Wenn Alles schön sich so vereinet,
Dann ist des Bieres Zweck erreicht;
Dann bringt es Segen über Segen
Der Menschheit froh auf allen Wegen.
Genießet so der Früchte Gaben.
Mit Heiterkeit mag es Euch laben.
Doch nie, o nie im wilden Rausche
Betäub' es Euch der Sinne Kraft;
Da sinkt der Mensch aus dem Geschlechte,
Tief sinkt er unter's Thier zurück,
Zertritt der Menschheit heil'ge Rechte,
Zertrümmert der Gesundheit Glück;
Und wo der wüthende Trunkenbold
Den Glanz der Tugend untergräbt,
Hat leider oft des Bieres Gold
Den gift'gen Zunder grausend belebt.
Und wüthend, wie das Element,
Wenn es der Schranken Raum durchbricht,
So erst der Mensch dann ohne End,
Wenn Rohheit den Verstand besiegt;
Und ärger als die freye Flamme,
Verbreit't er Elend, Schand und Spott,
Er sinkt und mit des Lasters Name
Sinkt er in Jammer, Noth und Tod.
Wohl furchtbar ist des Feuers Rachen,
Wenn wuthvoll es die Flur verheert,
Und fürchterlich der Erde Krachen,
Wenn sie von innerm Zittern bebt,
Noch gräßlicher des Sturmes Schall,
Wenn er verwirrt der Fluthen Bahn,
Doch unheilbringender als All,
Das ist der Mensch im trunknen Wahn.
Nein, laßt im Rausche Eurer Freuden
Euch nie durch blinde Leidenschaft
Verführen, daß zum ew'gen Leiden
Zerbrech' die edle Männerkraft.
Genießet mäßig Gottes Gaben,
Und seyd vergnügt, wie es sich ziemt;
Am edlen Gerstensaft sich laben,
Der König, wie der Bettler, rühmt.
Und nun füllt noch einmal die Becher
Auf's Wohlseyn aller muntern Zecher,
Schwingt die Gläser, schwingt,
Frohe Lieder singt,
Gesundheit allen Leut bedeute,
Frohsinn sei das Glas Geläute.
Stoßt an und laßt die Braukunst leben,
Und die Poesie daneben;
Denn bey der Gläser heiter'm Klang,
Erhöh' die Lust ein Lobgesang.

Vivat Bavaria, Du sollst leben:
Ich bring Dir froh dies Loblied dar,
Von innerm Dankgefühl durchdrungen,
Aus vollem Herz' hab ich's besungen,
Tön es noch laut manch frohes Jahr.

Bald kehr' auch ich zum lieben Heimaths-Strande;
Auch mir mag dort die Hoffnung winken,
Von diesen edlen braunen Tropfen
Auf Bayerns Wohl einmal zu trinken.
Ruf dann ich einst aus Nordens fernem Lande:
Ich hab erreicht den Zweck, den Wunsch gestillet,
An Pommerns Strand des Bieres Kraft enthüllet.

Vivat Patria, auch Du sollst leben
Ich kehre bald zu Dir zurück,
Voll Lust werd' ich die Arbeit dann beginnen
Aus voller Kraft den schönen Zweck vollbringen;
Tön' Pommern! dann des Bieres Loblied an.

Perl dann auch dort im schäumenden Pokale
O edler, edler Gerstensaft;
Mög' dann bescheiden meine Wünsche alle
Mein Vaterland erkennen, — des Bieres Kraft,
Es schlummert ja noch tief in diesen Zweigen.
Ruf ich die Kunst dann weckend einst hervor,
Aus fröhlicher und muntrer Zecher Reigen,
Noch fröhlicher ertön' der heitre Chor,
In Pommerns Ländern Bayern dann zu Ehren,
Auf Bayerns Wohl das erste Glas zu leeren. —

Gläserne Häuser sind bisher nur aus dem Sprichwort bekannt. Es gibt aber doch eins, das aus diesem zerbrechlichen Material hergestellt ist, nämlich eine Schenke in der Nähe Madrids, die in der Umgebung der spanischen Hauptstadt am Rande eines Wäldchens liegt und des Sonntags ein beliebter Ausflugsort ist. Als Baumaterial haben Flaschen aller Größen gedient, von kleinen zierlichen Likörflaschen bis zu den größten Weinflaschen und einem Flaschenriesen von drei Meter Höhe, der als Hauptpfeiler dient. Nach der Angabe des Wirtes waren über 3000 Flaschen nötig, um das Häuschen zu bauen; wer einmal in die Gegend kommt, mag also nachzählen.

*

Ein Münchener Kindl. — „Ich wünsch' Dir alles Gute zum Geburtstag, Vater, ... Glück und Gesundheit — und daß D' immer recht Durst hast!"

*

„Steffelbauer — mach' schnell, daß D' heimkammst, dei Haus ist abbrennt!"

Steffelbauer (der zwei Tag im Wirtshaus sitzt und zecht): „Wenn mir 's Haus abbrennt ist, nacha hab' i z'erst nix daheim z'tua — i bleib jetzt da, bis 's wieder aufbaut ist!"

*

„Wie ich mich freue, daß ich früher so viel getrunken habe!"

„„Wieso?""

„Der Doktor hat gesagt, daß ich mich künftig auf die Hälfte von dem beschränken muß, was ich sonst getrunken!"

*

Herr (zum Pantoffelhelden): „Das muß man sagen, Sie haben aber eine fleißige Frau; Sie saßen gestern um drei Uhr nachts noch in der Kneipe, da hat die schon mit dem Teppichklopfer in der Hand zum Fenster herausgeschaut!"

*

Wirt: „Herr Doktor, von vorgestern ist auch noch ein kleiner Rest stehen geblieben —"

Student: „Von vorgestern? Pfui Deibel! Na, van mir is er nich — ich trinke stets aus!"

*

„Ach herrjeh! Sie, Kellner, das Bier kostet ja fuffzehn Pfennche, und ich habe nur nach dreizehn. Wissen Se was? Ich lasse e Trebbchen steh'n!"

*

Student: „Pikkolo, spring' schnell 'nüber in die Goldene Traube und sieh' nach, ob die Herren von der Alemannia noch da sind!"

Pikkolo (zurückkehrend): „'s ist niemand drüben!"

Student: „Hast du denn auch unter die Tische geschaut . . .?"

*